Anritsu

INSTRUCTION MANUAL

OPTICAL POWER METER
ML93B
OPTICAL POWER SENSORS
MA95A, MA96A, MA97B, MA98A,
MA911A, MA912A, MA913A

ANRITSU CORP.

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ANRITSU CORP.

1986.07 x 100 NIII-3(Y)
Printed in Japan

CERTIFICATION

ANRITSU CORP. certifies that this instrument has been thoroughly tested and inspected, and found to meet published specifications prior to shipping.
Anritsu further certifies that its calibration measurements are based on the Japanese Electrotechnical Laboratory and Radio Research Laboratory standards.

WARRANTY

All Anritsu products are warranted against defects in material and workmanship. The warranty is effective for one year from the date of delivery. In the event of improper use, abuse, or damage due to natural catastrophe, the warranty will become void. Anritsu will repair or replace products which prove to be defective during the warranty period, provided they are returned to Anritsu.
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N O T E

(1) The instrument is operable on a nominal voltage from 100 to 130 Vac or from 200 to 260 Vac by changing the connections of the power transformer taps. (See Fig. 8-2)

The voltage and current rating are indicated on the rear panel when the instrument is shipped from the factory.

In the case of other voltage operation, change the connections of the power supply transformer, and the plate of voltage and current designations on the rear panel should be changed to suitable one.
Order the plates to ANRITSU CORP. if necessary.

(2) In this manual, a power supply voltage and current rating are represented by [**] Vac and [***] A.

(3) The relationship between power supply voltage and current rating is listed below.

** Vac	*** A
100 to 130 V	0.5 A
200 to 260 V	0.5 A

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SECTION 1

GENERAL

The ML93B Optical Power Meter is designed to measure optical power in conjunction with the MA95A/MA96A/MA97B/MA98A/MA911A/MA912A/MA913A Optical Power Sensor. The ML93B has 0.001 dB resolution (dB (REL) display) and is used for highly accurate measurements. The combinations of the Meter and the Sensor are shown as follows.

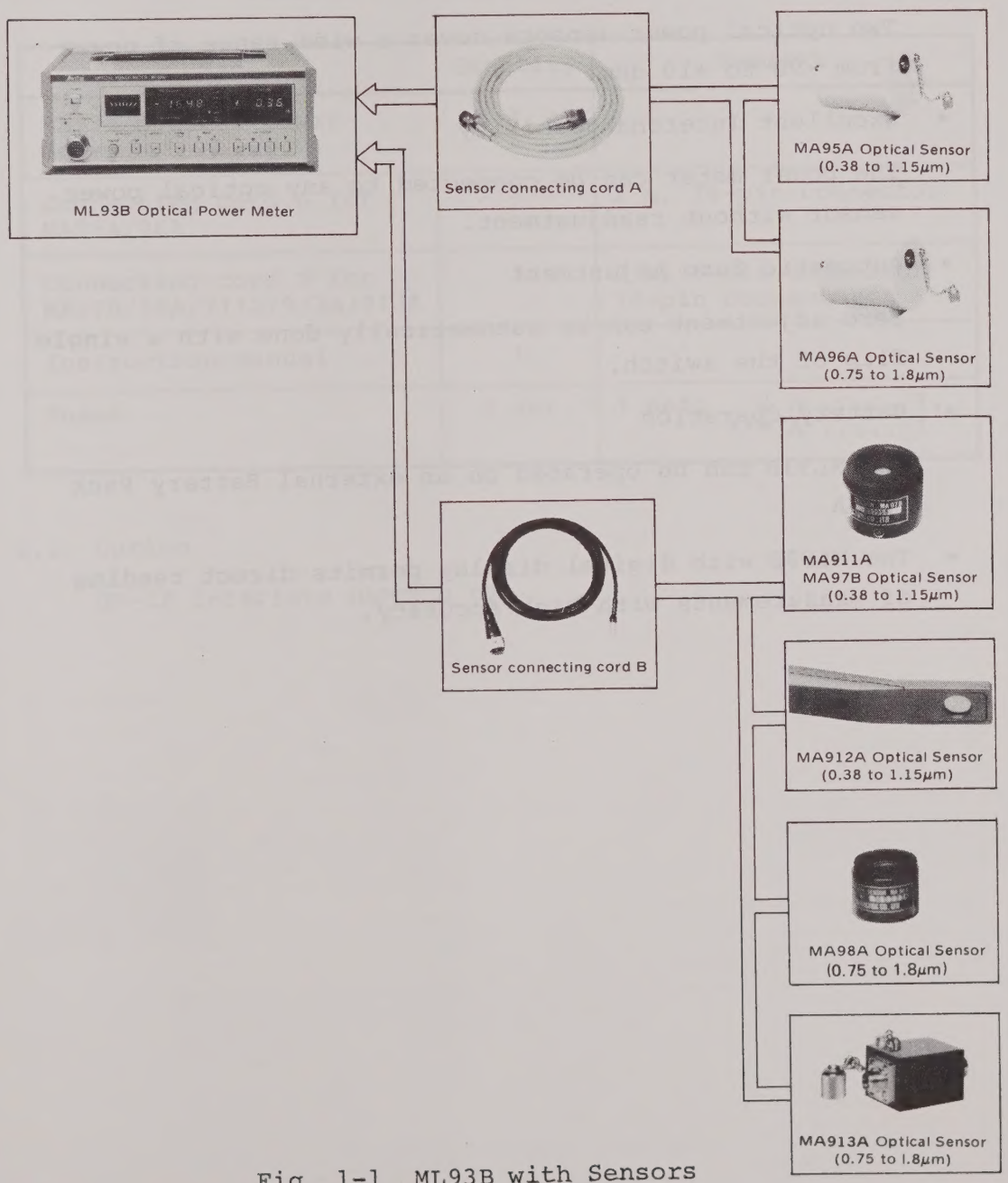


Fig. 1-1 ML93B with Sensors

Features

- Wide Wavelength Range

  Two optical power sensors cover a wavelength range from 0.38 to 1.8 µm.

- Wide Power Measuring Range

  Two optical power sensors cover a wide range of power from -90 to +10 dBm.

- Excellent Interchangeability

  The power meter can be connected to any optical power sensor without readjustment.

- Automatic Zero Adjustment

  Zero adjustment can be automatically done with a single flip of the switch.

- Battery Operation

  The ML93B can be operated on an external Battery Pack MZ95A.

- The ML93B with digital display permits direct reading of measurements with high accuracy.

SECTION 2

COMPOSITION AND SPECIFICATIONS

2.1 Standard Composition

Table 2-1 Standard Composition

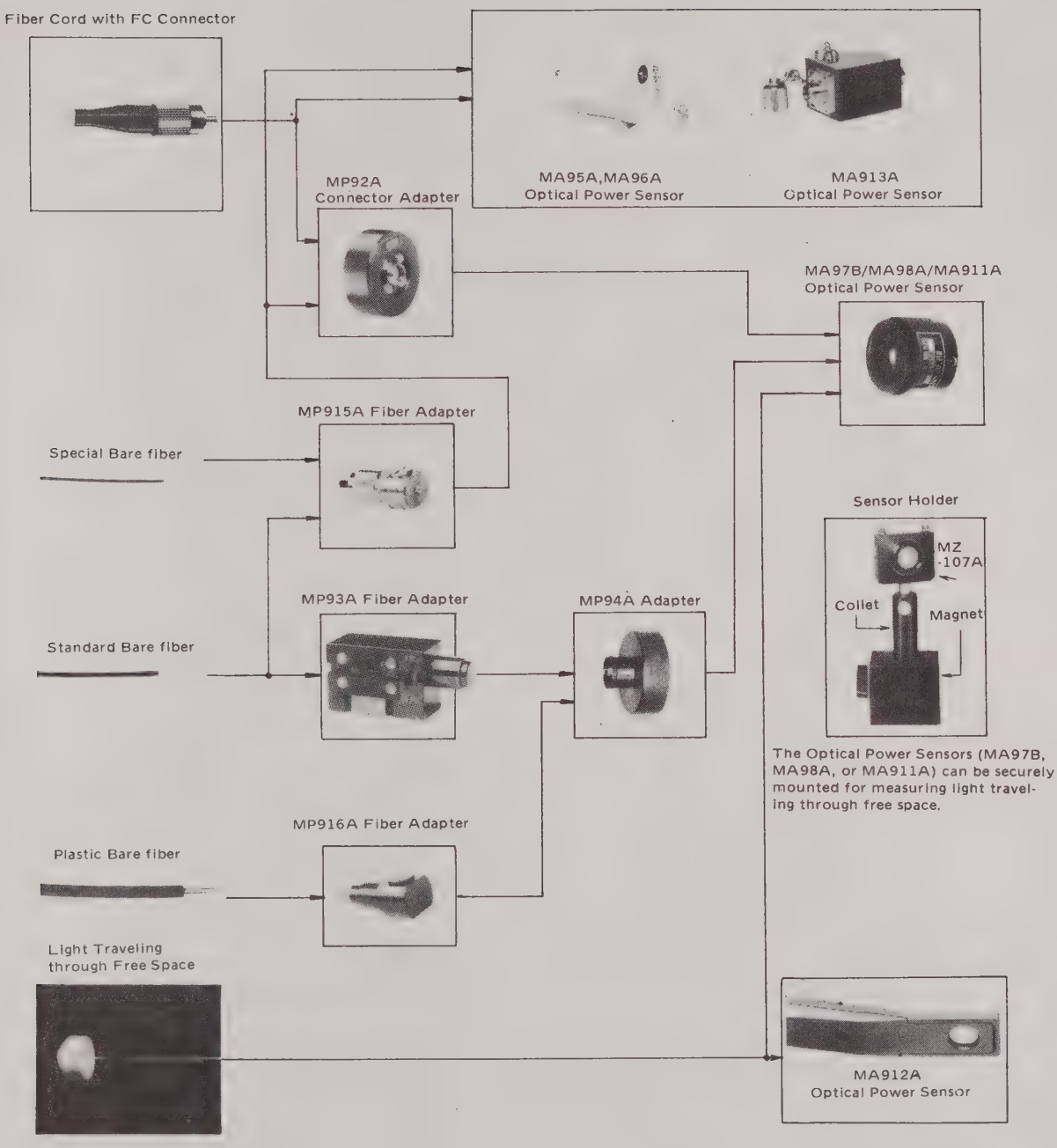
Name	Quantity	Remarks
ML93B optical power meter	1	
Connecting cord A for MA95A/96A	1	2 m, 16-pin connector
Connecting cord B for MA97B/98A/911A/912A/913A	1	2 m, 6-pin connector 16-pin connector
Instruction manual	1	
Fuses	1 set	1 set: 2 A ..... 1, *** A 1

2.2 Option

GP-IB interface (OPTION 02)

2.3 Optional Accessories

Name	Remarks
MA95A optical power sensor	
MA96A optical power sensor	
MA97B optical power sensor	
MA98A optical power sensor	
MA911A optical power sensor	
MA912A optical power sensor	
MA913A optical power sensor	
Connecting cord A for MA95A/96A	1.7 m, 16-pin connectors
Connecting cord B for MA97B/98B/911A/912A/913A	1.7 m, 6-pin connector, and 16-pin connector
Accessory Box	
MP915A fiber adapter	
MP92A connector adapter	
MP93A fiber adapter	
MP94A adapter for MP93A	
GP-IB cord	1 m
Conversion Connector	GP-IB ⟶ IEC-IB conversion
MZ95A battery pack	Approximately four hours operation (with no GP-IB)
MZ96A battery charger	
DC POWER SUPPLY cord	



. Standard fiber: Clad diameter of 0.125mm, nylon cover diameter of 0.9mm
. Special fiber: Clad diameter of 0.125mm, nylon cover diameter of 0.25 to 1mm
. Plastic fiber: Clad diameter of 1mm
For other fibers, consult Anritsu.

Fig. 2-1 Sensor Adapters

Table 2-2 Specifications

		Optical Power Meter ML93B					
Sensor	Model	MA95A	MA96A	MA97B	MA98A	MA911A/912A	MA913A
	Wavelength range	0.38 to 1.15 μm	0.75 to 1.8 μm	0.38 to 1.15 μm	0.75 to 1.8 μm	0.38 to 1.15 μm	0.75 to 1.8 μm
	Element	Si photo diode	Ge photo diode	Si photo diode	Ge photo diode	Si photo diode	Ge photo diode
	Active area diameter	——	——	D = 9.5 mm	D = 5 mm	D = 8 mm	——
	Input type	Connector*		Photo diode		Photo diode	Connector*
	Dimensions and weight	65 ϕ, 85 L mm ≦ 0.7 kg		35 ϕ, 27 L mm ≦ 0.1 kg (MA97B/98A/911A)/ 16 ϕ, 130 L mm ≦ 25 g (MA912A)			30 H, 25 W, 35 D mm ≦ 0.3 kg
Indicator	Model	ML93B					
	Display	Selection among Watts/dBm/dB (REL) Four digits and a small analog meter					
	Calibration coefficient	Front-panel adjustment					
	Recorder output	For each range, 1 V corresponding to full-scale and 0.316 V to -5 dB					
	Relative value display	Digital 4 digits, 0.001 dB					
	Averaging	ON/OFF switchable					
	Dimensions and weight	282 W, 99 H, 200 D mm ≦ 3.5 kg					
Overall	Power measuring range	-90 to 0 dBm (at 0.85 μm) 9 ranges	-80 to 0 dBm (at 1.3 μm) 8 ranges	-65 to +10 dBm (at 0.85 μm) 7 ranges	-40 to +10 dBm (at 1.3 μm) 5 ranges	-65 to +10 dBm (at 0.85 μm) 7 ranges	-50 to 0 dBm (at 1.3 μm) 6 ranges
	Accuracy	±5% (0.85 μm, -10 dBm)	±5% (1.3 μm, -10 dBm)	±5% (0.85 μm, -10 dBm)	±5% (1.3 μm, -10 dBm)	±5% (0.85 μm, -10 dBm)	±5% (1.3 μm, -10 dBm)
	Resolution	Watts display: 0.1 to 1% dBm display : 0.01 dB				dB (REL) display: 0.001 dB	
	Power	** V ±10%, 50/60 Hz, ≦20 VA or Battery Pack MZ95A or +9 to 20 V external DC power supply					

* The standard optical connector is the FC type.
Consult us should you need modification of the optical connector.

SECTION 3

PRINCIPLES OF OPERATION

3.1 Introduction

There are two types of circuits used in the ML93B optical power meter. One circuit uses an optical modulation method with an optical chopper. This circuit is used with the MA95A or 96A optical power sensor. The other circuit employs a direct detection method which does not require an optical chopper. This circuit is used with the MA97B, MA98A, MA911A, MA912A, or MA913A optical power sensor. Light input power is converted into electric power and displayed digitally by the ML93B optical power meter.

3.2 Optical Power Sensor

3.2.1 MA95A and MA96A Optical Power Sensors

The MA95A uses a silicon photodiode and the MA96A employes a germanium photodiode as the photoelectric conversion element. Fig.3-1 shows a block diagram of the optical power meter. The light input power from the light connector ① is focused by the lens ② on a shading plate on the tuning fork ③. The collimated light is interrupted by the tuning fork with a repetition frequency of approx. 270 Hz and then concentrated on the photodiode ⑤ by the lens ④. It is converted into photoelectric current and then converted further into voltage by the current-to-voltage conversion circuit ⑥, which is an operational amplifier. The conversion circuit ⑥ controls the gain according to the input optical power level over three ranges, 0 to -30 dBm, -30 to -60 dBm and -60 to -90 dBm to expand the dynamic range of the optical power sensor.

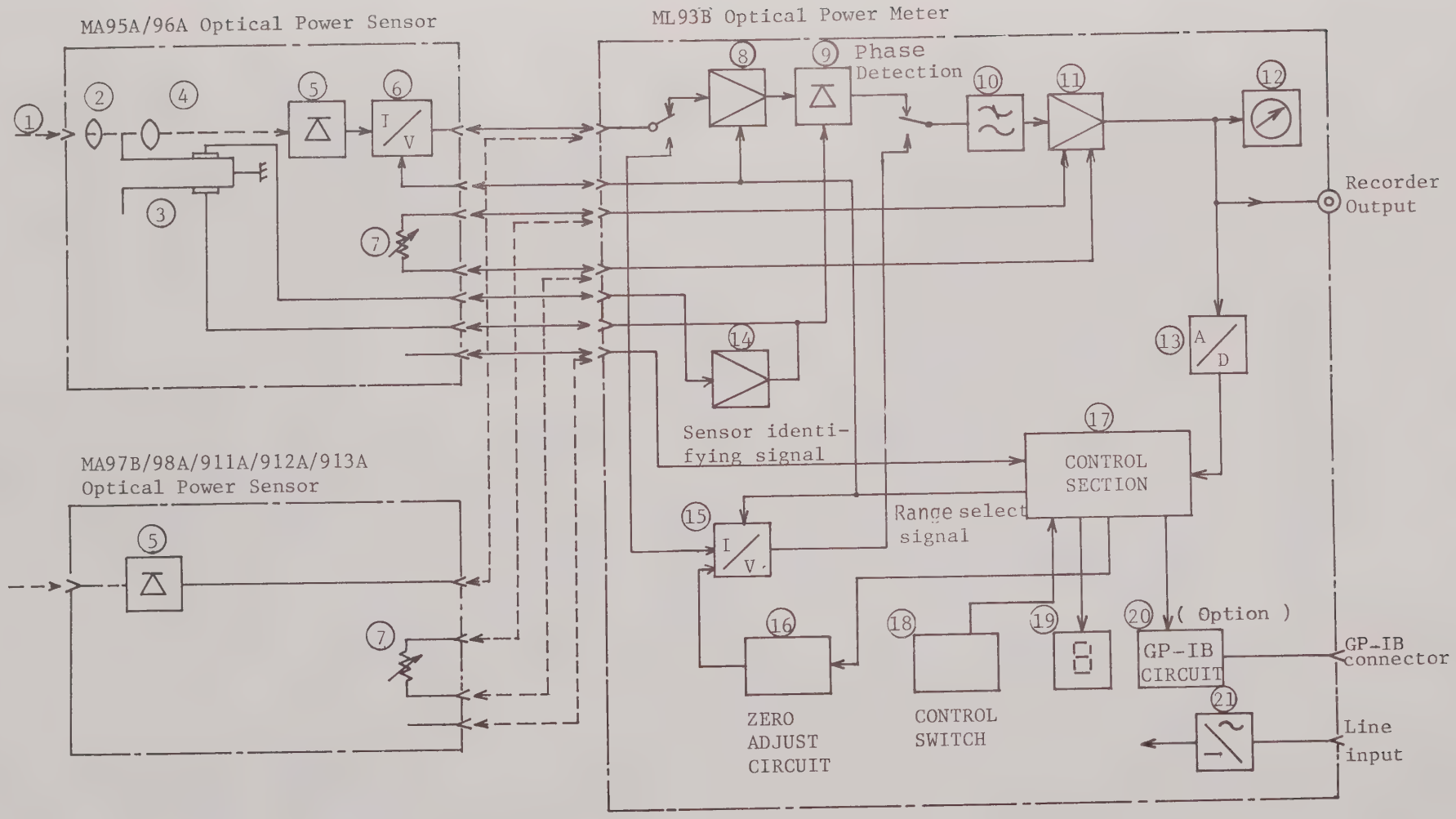


Fig. 3-1 Optical Power Meter Block Diagram

The overall gain in combination with the optical power meter and optical power sensor is made constant, irrespective of the sensor, by the sensitivity adjustment ⑦ which compensates for variance in photodiode sensitivity.

3.2.2 MA97B, MA98A, MA911A, MA912A, and MA913A Optical Power Sensors

The MA97B, MA911A and MA912A use a silicon photodiode and the MA98A and MA913A use a germanium photodiode as the photoelectric conversion element. These sensors only contain photodiode ⑤ and sensitivity adjustment ⑦ described in Section 3.2.1. The conversion circuit ⑥ is in the ML93B optical power meter.

3.3 ML93B Optical Power Meter (Indicator)

Indicator displays optical power converted into photoelectric current by the optical power sensor in digital form. Each optical power sensor is given a unique identifier signal by which the control section automatically determines which sensor is currently connected. The control section selects the amplifier circuit ⑧, phase detection circuit ⑨ and the tuning fork oscillator circuit ⑭ when sensor MA95A or 96A is connected. The current-to-voltage conversion circuit ⑮ and the zero adjusting circuit ⑯ are selected when MA97B, MA98A, MA911A, MA912A, or MA913A is connected.

The signal output from a MA95A or 96A sensor is switched to suitable range in the amplifier circuit ⑧.

It then passes through the phase detection circuit ⑨ and enters the low-pass filter ⑩. When the MA97B, MA98A, MA911A, MA912A, or MA913A sensor is connected, the signal is switched to suitable range in the current-to-voltage conversion circuit ⑮ before entering the low-pass filter ⑩.

The variable resistor (7) in each sensor adjusts the gain in the amplifier circuit (11) to adjust sensitivity. The detected signal is digitized by the A/D converter (13), processed in the microprocessor control section (17) and then indicated on the numeric display (19). The detected signal is branched to the signal level meter (12) and to the recorder output (4).

The zero adjust circuit (16) is used to compensate for variations of offset voltage which occur when the MA97B, MA98A, MA911A, MA912A, or MA913A sensor is connected.

When the GP-IB circuit (20) (option) is connected, the instrument can be controlled externally and measurement results can be output.

SECTION 4

OPERATION

4.1 Operating and Storage Conditions

This instrument is designed to operate normally in an ambient temperature range of 0° to 45°C. For best operation, however, it should be used at normal room temperature whenever possible. Do not use or store the instrument in locations

1. where vibrations are severe.
2. where it is damp or dusty.
3. where there is exposure to direct sunlight.
4. where there is exposure to active gases.
5. where there is exposure to magnetism.
6. where oxidation or rusting may occur.

The instrument should be stored in a temperature range of -5° to 50°C, and a humidity range of 40% to 80%. It should be cleaned before storage. The sotrage area should not be subject to large fluctuations in temperature over a 24-hour period.

If this instrument is operated at room temperature after being used or stored for a long period at low temperatures, condensation may occur and cause short-circuiting. To prevent this, do not turn the power on until the instrument is completely dry.

4.2 Power Requirements

The ML93B operates on ** Vac ±10%, 50 or 60 Hz, as indicated on the rear panel. (See Note at the beginning of this manual.)

When changing the nominal ac line voltage rating, change the wiring on the appropriate primary taps of the power transformer according to Fig. 8-2.

CAUTION

1. To avoid electric shock, ground the ⏚ terminal on the rear panel or ground the ground terminal of the power cord when power is supplied from a double-pole wall socket.
2. Make sure the power switch is off and power supply cord unplugged whenever replacing fuses.

4.3 Controls and Functions

4.3.1 MA95A/96A Optical Power Sensors

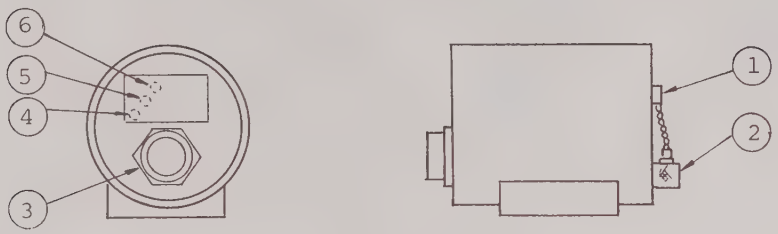


Fig. 4-1 MA95A/96A Optical Power Sensors

No.		Description of function
①	Light input connector :	Attaches the optical fiber connector for measurement.
②	Cover :	Protects the light input area. Also used for zero adjustment by shutting off the light input.
③	Receptacle :	Connected to the ML93B with the supplied connecting cord A.
④	Sensitivity adjustment :	Component No. R14 (located under the label).
⑤	Sensitivity adjustment :	Component No. R8 (located under the label).
⑥	Sensitivity adjustment :	Component No. R11 (located under the label).

4.3.2 MA97B/98A/911A/913A Optical Power Sensors

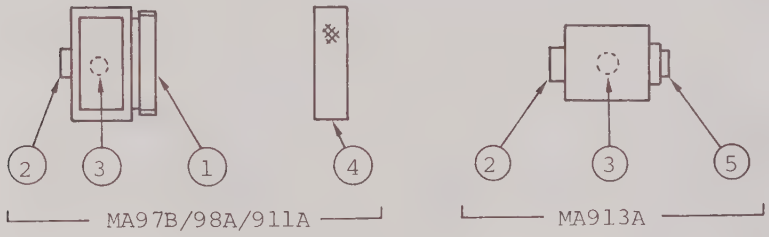


Fig. 4-2 MA97B/98A/911A/913A Optical Power Sensors

No.		Description of function
①	Light input area :	Receives the light to be measured.
②	Receptacle :	Connected to the ML93B with the supplied connecting cord B.
③	Sensitivity adjustment :	Adjusts the photodiode sensitivity. Component No. R2.
④	Cover :	Protects the light input area. Also used for zero adjustment by shutting off the light input.
⑤	Light input connector :	Attaches the optical fiber connector for measurement.

4.3.3 MA912A Optical Power Sensor

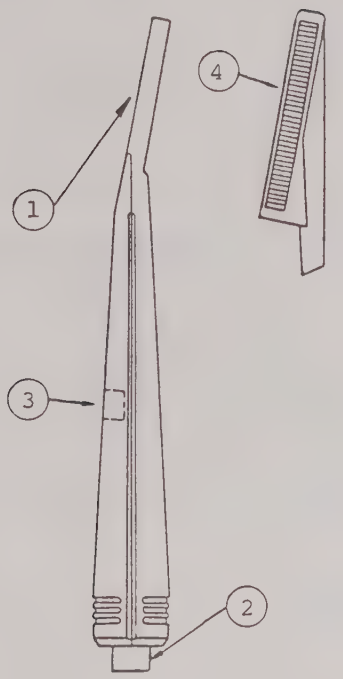


Fig. 4-3 MA912A Optical Power Sensor

No.		Description of function
①	Light input area :	Receives the light to be measured.
②	Receptacle :	Connected to the ML93B with the supplied connecting cord B.
③	Sensitivity adjustment :	Adjusts the photodiode sensitivity. Component No. R2.
④	Cover :	Protects the light input area. Also used for zero adjustment by shutting off the light input.

4.3.4 ML93B Optical Power Meter

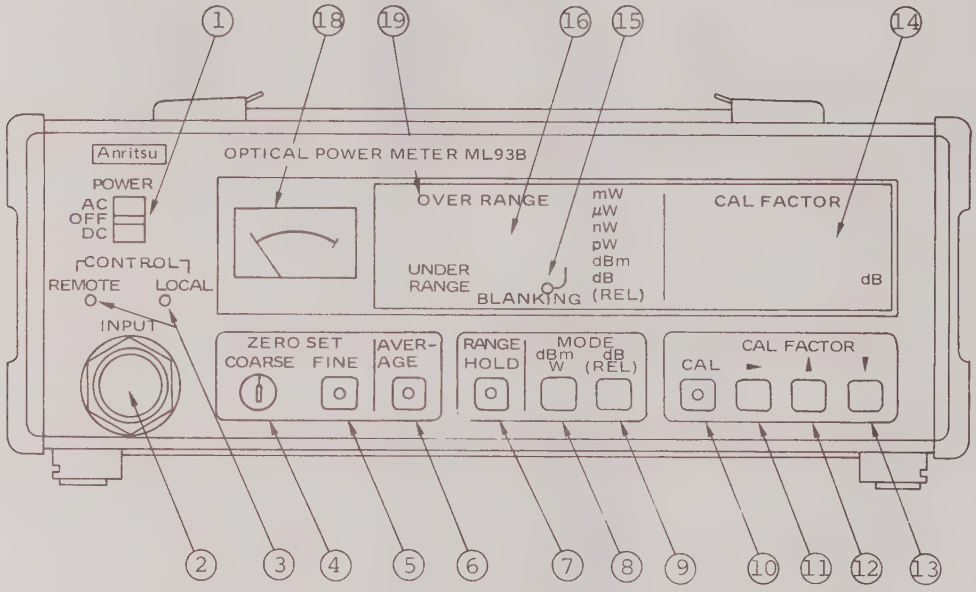


Fig. 4-4 Front Panel

Table 4-1 Front Panel Controls and Functions

No.	Indication	Function
①	Power	Power switch
	AC	AC power supply
	OFF	OFF
	DC	MZ95A battery pack (approximately four hours battery operation with no GP-IB option) or other external DC power supply.
②	INPUT	INPUT receptacle. Socket for connection of optical power sensor connecting cord.

Table 4-1 Front Panel Controls and Functions (Cont'd)

No.	Indication	Function
③	CONTROL REMOTE LOCAL	CONTROL indicators. REMOTE is lit when the ML93B is operating in remote mode using an external controller through GP-IB. Otherwise, LOCAL is lit.
④	ZERO SET COARSE	Zero adjustment knob ④ and switch ⑤ (see below). Used only when the MA97B/98A/911A/912A/913A optical power sensor is connected. Adjusts zero point when the optical power sensor is changed or if ambient temperature varies greatly. (Coarse adjustment.)
⑤	FINE	The zero point is adjusted automatically when this switch is pressed. · If the MA95A/96A optical power sensors is connected, the zero point is automatically adjusted when this switch is pressed. If the optical power sensor is to be used in the highest sensitivity range, press this switch after setting the AVERAGING switch ⑥ to ON. · If the MA97B/98A/911A/912A/913A optical power sensor is connected, the zero point is precisely adjusted when this switch is pressed after adjustment with the COARSE knob. The coarse adjustment must be within 10% of the value of the highest sensitivity range used.
⑥	AVERAGE	Averaging ON/OFF switch. When this switch is turned on, the display ⑯ is indicated an integrated value to reduce short-term noise. The LED on the switch indicates whether the averaging function is on or off. The RECORDER OUTPUT is not averaged.
⑦	RANGE HOLD	Automatic Range/Range Hold Selection Switch. Range Hold for quick response. When this switch is pressed, the range is held and the LED on the switch comes on. When the switch is pressed again, the automatic range function is restored.

Table 4-1 Front Panel Controls and Functions (Cont'd)

No.	Indication	Function
⑧	MODE dBm W	Watt/dBm selection switch. Measured values can be displayed in units of dBm or watts. The unit can be changed alternately by pressing selection switch. The selected unit of measurement is indicated by the LED on the display ⑯ .
⑨	MODE dB (REL)	When the dB (REL) switch is pressed, the current measured value is stored in the internal memory. The ratio between the stored value and subsequent measured value (difference in dB) is displayed. The relative value (>-10 dB, <+10 dB) is indicated in units of 0.001 resolution. If the measuring dynamic range exceeds ±9.999 dB of the relative value, the relative value resolution is automatically changed to 0.01 dB. The dB (REL) function is released by pressing the dBm/W switch ⑧; the display is then in dBm.
⑩	CAL FACTOR CAL	Sensor calibration value set switch. The calibration factor can be changed with switches ⑪ , ⑫ , and ⑬ when the CAL switch ⑩ is ON. During the CAL switch is on, one of these LEDs on the CAL factor display ⑭ blinks to indicate a settable digit. After CAL factor setting on the display ⑭ is finished (refer to the No. ⑪ , ⑫ , ⑬), then repress the CAL switch ⑩ . At this time, the LED on the CAL switch goes off. Numeric display ⑯ indicates the sensor calibrated value including this set CAL factor.
⑪	▶	The variable digit shifts to the right each time this button is pressed.
⑫	▲	The numeric value of the blinking digit increments each time this button is pressed.
⑬	▼	The numeric value on the blinking digit decrements each time this button is pressed. The sign is alternated from + to - each time either switch ⑫ or ⑬ is pressed.

Table 4-1 Front Panel Controls and Functions (Cont'd)

No.	Indication	Function
⑭		CAL factor display: Indicates a 4-digit number and plus (+) or minus (-) sign for polarity of the measured value.
⑮	BLANKING	Suppression switch for the display of the least significant digit of the measured value display ⑯.
⑯		Numeric display: Indicates a 4-digit number and plus (+) or minus (-) sign for polarity of the measured value.
⑰	OVER RANGE UNDER RANGE	The applicable LED lights up to indicate whether the light input to be measured is over- or under-range.
⑱		The meter indicates the approximate value of the measurement result.

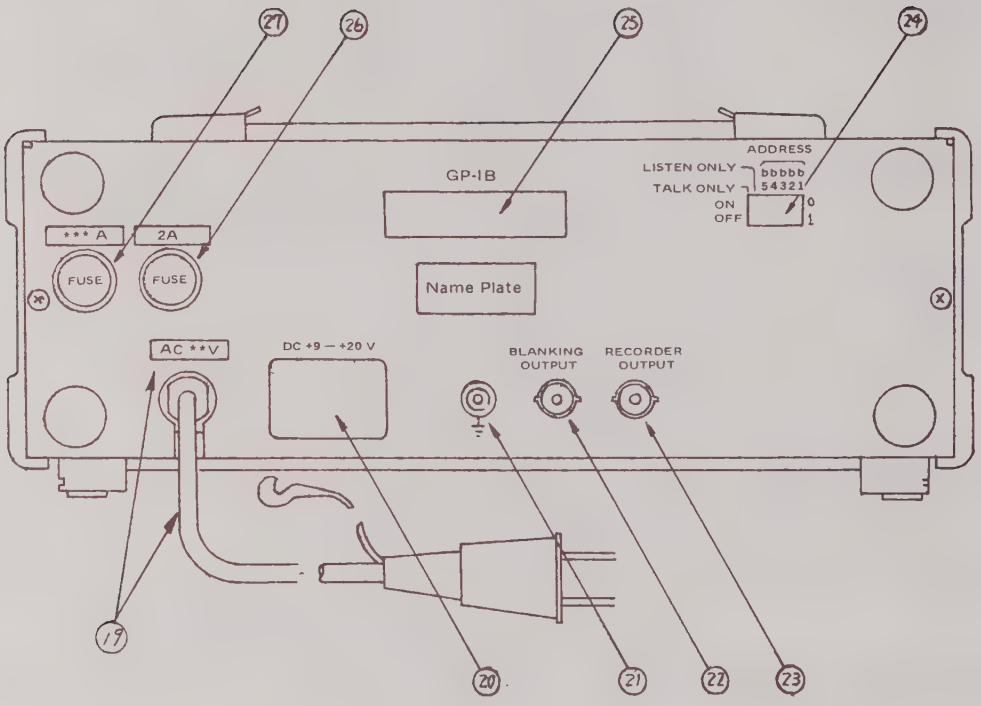


Fig. 4-5 Rear Panel

Table 4-2 Rear Panel Controls and Functions

No.	Indication	Function
(19)	AC ** V	ac power cord (See Note at the beginning of this manual.)
(20)	DC +9 - +20 V	Input connector for MZ95A battery pack (approximately four hours operation with no GP-IB) or external dc power supply. The instrument is connected to an external DC power supply with an optionally supplied cord. Supply voltage between +9 and +20 V is required. And then DC power is supplied when power switch (1) is set to the DC position.

Table 4-2 Rear Panel Controls and Functions (Cont'd)

No.	Indication	Function
㉑	⏚	Ground terminal. Should be well-grounded to avoid electrical shocks.
㉒	BLANKING OUTPUT	Grounded during zero adjustment with open collector output.
㉓	RECORDER OUTPUT	Recorder output connector. The voltage corresponding to the W (watt) scale is output: 1 V corresponding to the full scale and 0.316 V to -5 dB. This output is not averaged.
㉔	ADDRESS (option)	Enables address setting when using the GP-IB interface.
㉕	GP-IB (option)	GP-IB connector
㉖	FUSE 2 A	dc power supply fuse.
㉗	FUSE *** A	ac power supply fuse. Make sure the power switch is off and the power supply cord unplugged whenever replacing fuses.

4.4 Measurement

4.4.1 Notes on Measurement

1) Make sure the ground terminal (21) on the rear panel is well-connected to ground.

2) Excessive light input will damage the photodiode. Do not input light exceeding the specified value.

3) When using the instrument in a light place, be careful to avoid interference.

4) Sensitivity will change if the light source is exposed to a place other than the active area of the crystal element. Be careful to place other than the active area of the crystal element. Be careful to place the light source to be measured within the active area of the MA97B/98A/912A optical power sensor when it is used without the connector adapter.

5) If a low impedance circuit or instrument is connected to the recorder output terminal, the recorded value will not be accurate. Use a recorder with an input impedance of at least 100 kΩ.

   The recorder output is not averaged. When measuring low-level light input, insert an appropriate smoothing circuit into the input of the recorder to procedure a record of averaged values.

6) Instrument functions are initialized (refer to 4.4.3 (1)) whenever the power is turned on again after ac power operation is interrupted.

7) If a high-amplitude spike enters through the power line, the instrument may fail to operate normally. Turn the power off and then on again to reinitialize the instrument in such a case.

4.4.2 Power Supply

(1) AC Power Supply

Verify that the POWER switch (1) is set to OFF and that the line voltage is ** V ac ±10%. Connect the power cord to the ac line.

(2) MZ95A Battery Pack

Verify the POWER switch (1) is set to OFF. Connect the MZ95A battery pack to the connector (20). Refer to the MZ95A Instruction Manual.

(3) External DC Power Supply

Verify that POWER switch (1) is set to OFF. Connect the DC power supply to connector (20) with the optionally supplied cord.

4.4.3 Measurement

(1) Connect the optical power sensor to the ML93B optical power meter with the sensor connecting cord and turn on the power.

When the power is turned on, the functions are initialized as follows:

(i)	Zero adjustment	:	OFF
(ii)	Average	:	OFF
(iii)	Range	:	Automatic range (the range with the highest sensitivity is determined by the optical power sensor)
(iv)	Mode	:	dBm
(v)	CAL switch	:	OFF
(vi)	Calibration Factor	:	0.00 dB

(2) Shut off any light input using the cover attached to the optical power sensor and press the automatic zero set switch.

After the MA95A/96A optical power sensor is connected, if an accurate zero adjustment is required, turn on the AVERAGE switch (6) and press the ZERO SET FINE button (5). The LED lights up and goes off when the zero adjustment is finished, in approximately 3 seconds.

When the MA97B/98A/911A/912A/913A optical power sensor is connected, adjust the numeric display (16) with the ZERO SET COARSE knob (4) so that the displayed value is below 10% of the highest sensitivity range and press the ZERO SET FINE button (5). The LED goes off in approximately 20 seconds after the completion of zero adjustment.

(3) Set the CAL FACTOR, MODE, RANGE HOLD switches as required and input the light to be measured.

The measurement result is displayed on the numeric display (16) in 4 digits from 0.00 to 99.99 with a sign digit. The approximate value of the measurement is indicated by the meter (18).

Press the BLANKING switch (15) to suppress the least significant digit.

(4) Refer to Section 5 below for information remote control using the GP-IB option.

(5) The response of the optical power sensor varies at different wavelengths. The detection response of MA95A, MA97B, MA911A, and MA912A is calibrated at the 0.85 μm wavelength and MA96A, MA98A, and MA913A are calibrated at 1.3 μm. Therefore, responsivity compensation is required when measuring optical power at wavelengths other than those given above. Sensor responsivity - wavelengths curves can be supplied on request (option, refer to Fig. 6-1).

Responsivity variations are compensated for in the manner described below. If the responsivity of MA95A at 1 μm is -1 dB, set the CAL FACTOR to "-1.00" when measuring optical power at 1 μm, the measured value will be accurately compensated.

(6) The relative value is indicated when the dB (REL) switch is pressed. The value is displayed in units of 0.001 dB resolution. When the BLANKING switch is pressed, the smallest digit is erased and the display is changed to 0.01 dB resolution indication.

If the measuring dynamic range exceeds +9.999 dB of the relative value, the relative value resolution is automatically changed to 0.01 dB.

Take care when changing the measurement range during measurements of 0.001 dB resolution because errors are generated between ranges. More stable measurements can be made by turning on the AVERAGE switch for 0.001 dB resolution measurements.

SECTION 5

GP-IB (OPTION 02)

5.1 Introduction

The GP-IB interface option satisfies all standard specifications for GP interface bus. Programmable automatic measurements can be carried out with any controller conforming to specifications for an GP interface bus. When this option is connected to a data output device, such as a printer, which has a listener function, a record of measured power can be obtained.

5.2 Interface Functions

The GP-IB has the following functions:

Function	Description
SH1	Complete source handshake functions
AH1	Complete acceptor handshake functions
L3	Basic listener function The listener function can be released by MTA. Listen-only mode
T5	Basic talker function Serial pole function Talk-only mode The talk function can be released by MLA.
SR0	Not including the service request function
RL1	Including the remote operation/local operation selecting function
PP0	Not including the parallel pole function
DC0	Not including the device clear function
DT0	Not including the device trigger function
C0	Not including the control function

Note: The POWER switch and the COARSE ZERO knob on the front panel of the ML93B optical power meter are enabled during remote operation.

5.3 Programming Codes

All programming codes are ASCII codes.

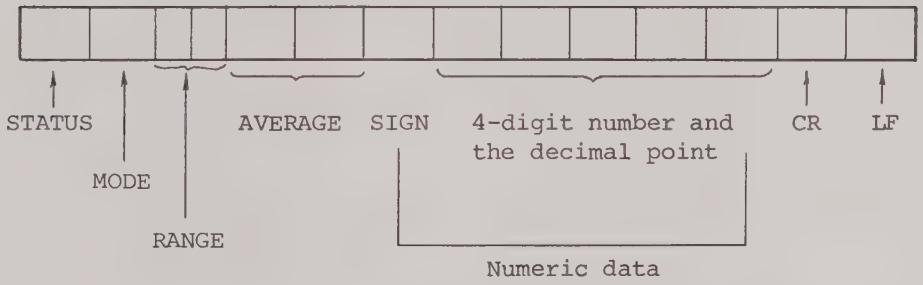
(a) Input Programming Codes

Function	Contents	Programming Code
RANGE specification	RANGE HOLD: +10 dBm (10 mW) range	A0
	RANGE HOLD: 0 dBm (1 mW) range	A1
	RANGE HOLD: -10 dBm (100 µW) range	A2
	RANGE HOLD: -20 dBm (10 µW) range	A3
	RANGE HOLD: -30 dBm (1 µW) range	A4
	RANGE HOLD: -40 dBm (100 nW) range	A5
	RANGE HOLD: -50 dBm (10 nW) range	A6
	RANGE HOLD: -60 dBm (100 pW) range	A7
	RANGE HOLD: -70 dBm (100 pW) range	A8
	RANGE HOLD: -80 dBm (10 pW) range	A9
	AUTO RANGE	B
Display mode	WATT display	C0
	dBm display	C1
	dB (REL) display	C2
CAL. FACTOR	CAL. FACTOR data format	CAL. FACTOR 4 digits The decimal point is assumed to be in the third digit location. Example: 1234 = 12.34
AVERAGING	AVERAGING ON	E0
	AVERAGING OFF	E1
ZERO SET (FINE ZERO)	ZERO SET ON	Z

Function	Contents	Programming Code
Measurement rate	HOLD (No measurement)	F0
	FREE RUN (Continuous measurements at the same rate as operations of key switches on the front panel.)	F1
	EXT TRIGGER (Switched to HOLD MODE after each measurement)	F2

(b) Output Data Format

This option outputs data in the format shown below:

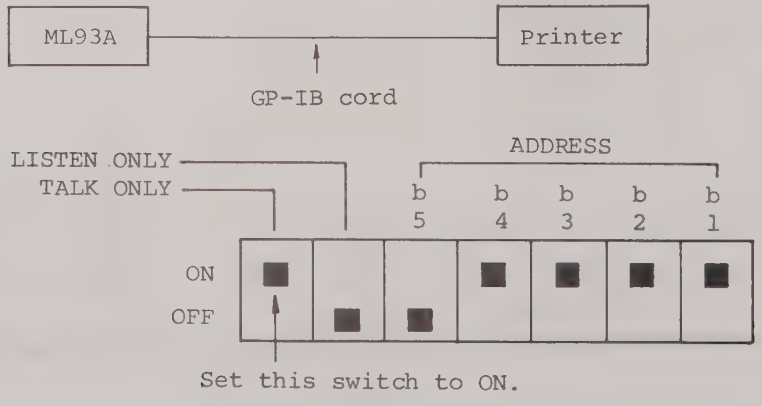


Function	Contents	Programming Code
STATUS	OVER RANGE	V
	UNDER RANGE	W
	IN RANGE	X
MODE	mW	P
	μW	Q
	nW	R
	pW	S
	dBm	T
	dB (REL)	U

Fuction	Contents	Programming Code
RANGE	RANGE HOLD: +10 dBm (10 mW) range	A0
	RANGE HOLD: 0 dBm (1 mW) range	A1
	RANGE HOLD: -10 dBm (100 µW) range	A2
	RANGE HOLD: -20 dBm (10 µW) range	A3
	RANGE HOLD: -30 dBm (1 µW) range	A4
	RANGE HOLD: -40 dBm (100 nW) range	A5
	RANGE HOLD: -50 dBm (10 nW) range	A6
	RANGE HOLD: -60 dBm (1 nW) range	A7
	RANGE HOLD: -70 dBm (100 pW) range	A8
	RANGE HOLD: -80 dBm (10 pW) range	A9
	AUTO RANGE	AB
AVERAGE	With AVERAGING	E0
	Without AVERAGING	E1
Sign for measured value	Positive	+
	Negative	-

5.4 Instructions for Operation

(a) When using the power meter with a data output device having a listener function, set the ADDRESS switch on the rear panel to TALK ONLY mode (refer to the diagram below).



(b) When Connected to a Controller for Programmable Automatic Measurement

Set the device address with the ADDRESS switches b1 to b5 on the rear panel. The address set shown in the example is 15. Set the TALK ONLY switch to OFF.

If the Anritsu PACKET IIe personal computer or DPR7713A printer is being used, the following table is applicable.

Measurement Method	Program Example	Remarks
FREE RUN (Continuous measurement)	0 PRINTER IS @ 117 DIM A$*64 1 READ @ 115 USING "C14": A$ 2 PRINT A$ 3 GOTO 1 4 END	FREE RUN MODE when ML93B power is turned on.
EXT TRIGGER (Single measurement)	0 PRINTER IS @ 117 DIM A$*64 1 COMMAND @ 1: "?P/";"F2" 2 READ @ 115 USING "C14": A$ 3 PRINT A$ 4 END	? → UNL P → TALK ADDRESS of controller. 1 → LSN. ADDRESS of ML93B
Others	REN @ 115 LCL @ 115	REMOTE operation. Switches on the front panel are disabled. LOCAL operation.

Notes:

1. ZERO SET operation requires the time indicated below.
   20 seconds for MA97B/98A/911A/912A/913A
   3 seconds for MA95A/96A

2. Maximaly 5 seconds is required for the measured value to stabilize after RANGE is switched.

5.5 LISTEN ONLY and TALK ONLY Modes

Connect Optical Power Meter I and II with GP-IB cord as shown in Fig. 5-1. When the Optical Power Meter I is set to TALK ONLY and II to LISTEN ONLY, a display as shown in Fig. 5-2 will be seen. And the measured result of the Optical Power Meter I is displayed in the part of CAL FACTOR of the Optical Power Meter II.

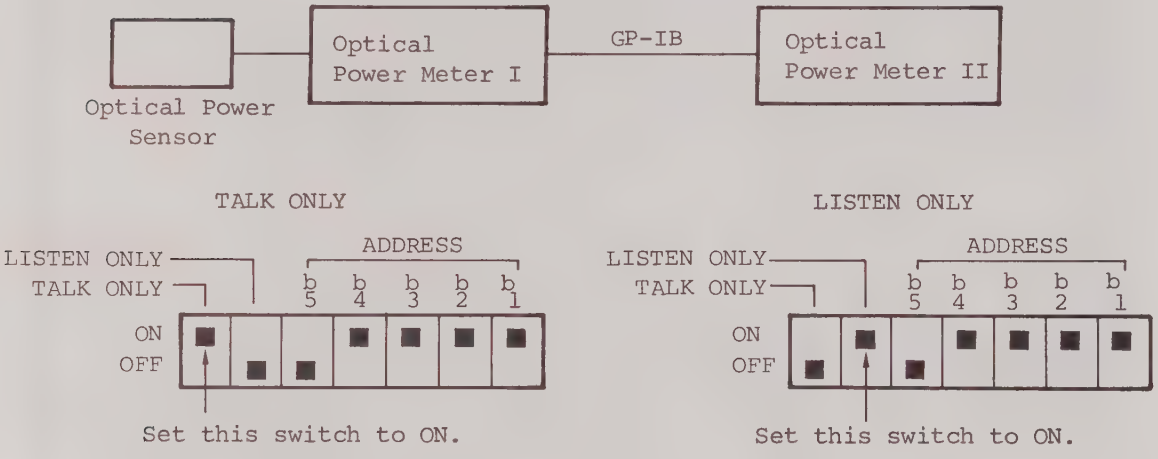
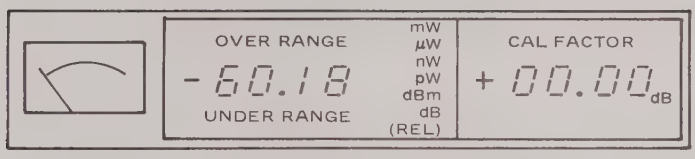


Fig. 5-1 Connection of Optical Power Meters

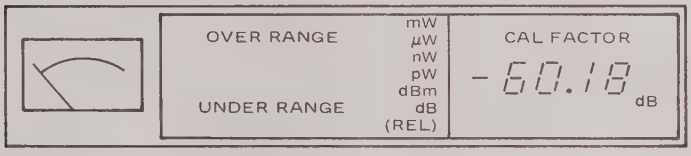
Note on GP-IB address:

GP-IB address can specify 0 to 30.

31 (11111) is UNL (unlisten) or UNT (untalk) command of multi-line message, so can not be specified as a GP-IB address.



Display of Optical Power Meter set to TALK ONLY



Display of Optical Power Meter set to LISTEN ONLY

Note 1: The cases that the LISTEN ONLY mode Optical Power Meter shows [ER] are as follows:

a. The first letter of the input data is not " V ", " W " or " X ". Refer to Page 5-3, (b) Output Data Format.

b. The second letter of the input data is not " T ".

Note 2: The case that the LISTEN ONLY mode Optical Power Meter shows no result or blanking is because of which the next input data is not received within about a second (56 count) after the first input data has been received.

Note 3: When the Optical Power Meter I shows UNDER RANGE or OVER RANGE, the Optical Power Meter II displays " UL " or " OL ", respectively.

Fig. 5-2 TALK ONLY and LISTEN ONLY

SECTION 6

PERFORMANCE TEST

6.1 Introduction and Description

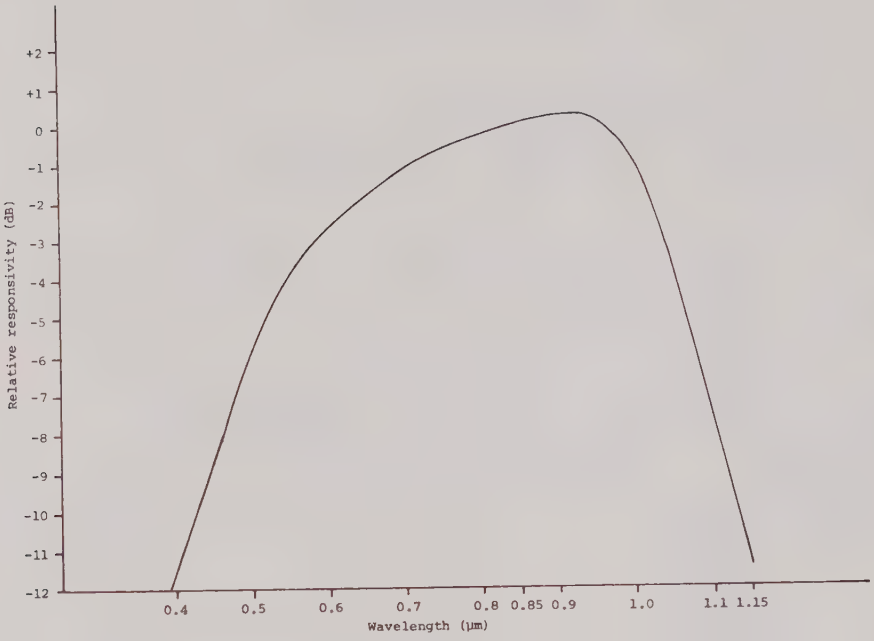
The TEST INSTRUMENT is calibrated according to Table 6-1.

The TEST PERFORMANCE SHEET is prepared on page 6-16 to 6-22. Environmental range at which specifications apply: Temperature 25°C Relative humidity 63%

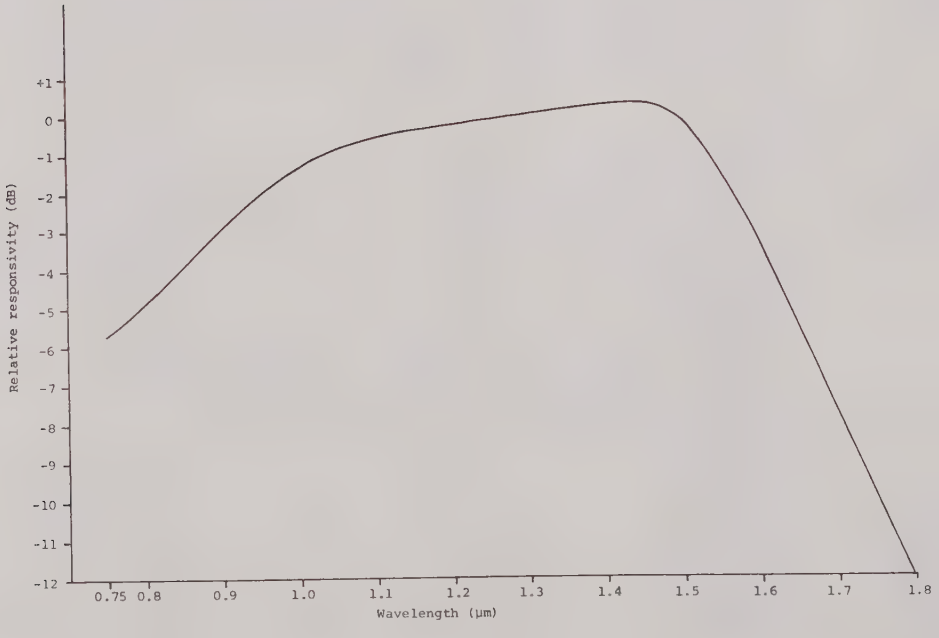
Table 6-1 Calibration Description

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS		TEST METHOD
1. WAVELENGTH RANGE	MA95A MA97B MA911A MA912A	0.38 to 1.15 μm	The wavelength range is measured by using a xenon lamp, monochromator, and reference sensor.
	MA96A MA98A MA913A	0.75 to 1.8 μm	
2. RECORDER OUTPUT	Proportional to indicated power with 1 V corresponding to full scale and 0.316 V to -5 dB, in each range with high impedance load (>10 kΩ).		The recorder output is measured by using a light source, attenuator, and digital voltmeter.
3. POWER MEASURING RANGE	MA95A	-90 dBm to 0 dBm (at 0.85 μm)	The power measuring range is measured by using a reference power meter, light source, and optical attenuator.
	MA96A	-80 dBm to 0 dBm (at 1.3 μm)	
	MA97B MA911A MA912A	-65 dBm to +10 dBm (at 0.85 μm)	
	MA98A	-40 dBm to +10 dBm (at 1.3 μm)	
	MA913A	-50 dBm to 0 dBm (at 1.3 μm)	
4. ACCURACY Meter and sensor combination at specific interface accuracy over amplitude range.	MA95A MA97B MA911A MA912A	±5% (at 0.85 μm, -10 dBm)	The accuracy is measured by using a standard optical power meter, light source, optical attenuator, and dummy fiber. *
	MA96A MA98A MA913A	±5% (at 1.3 μm, -10 dBm)	

* Note: Figure 6-1 shows wavelength responsivity of sensor.

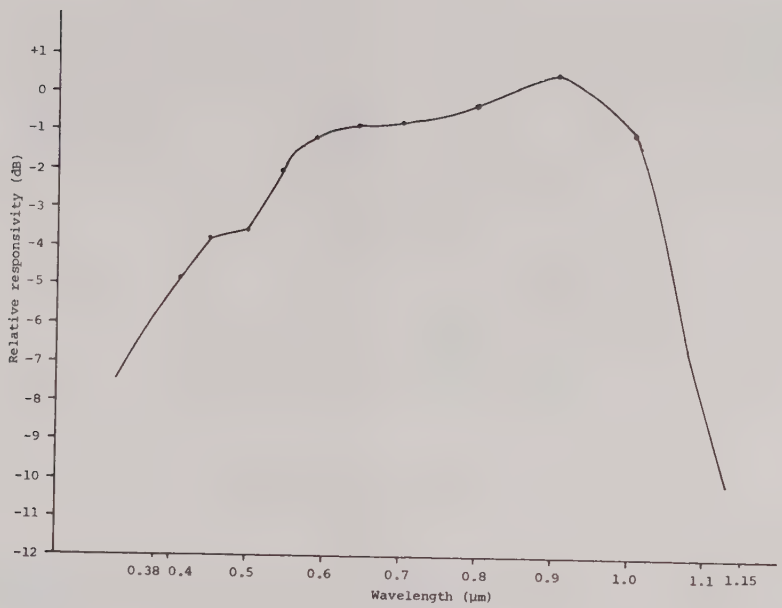


(A) MA95A

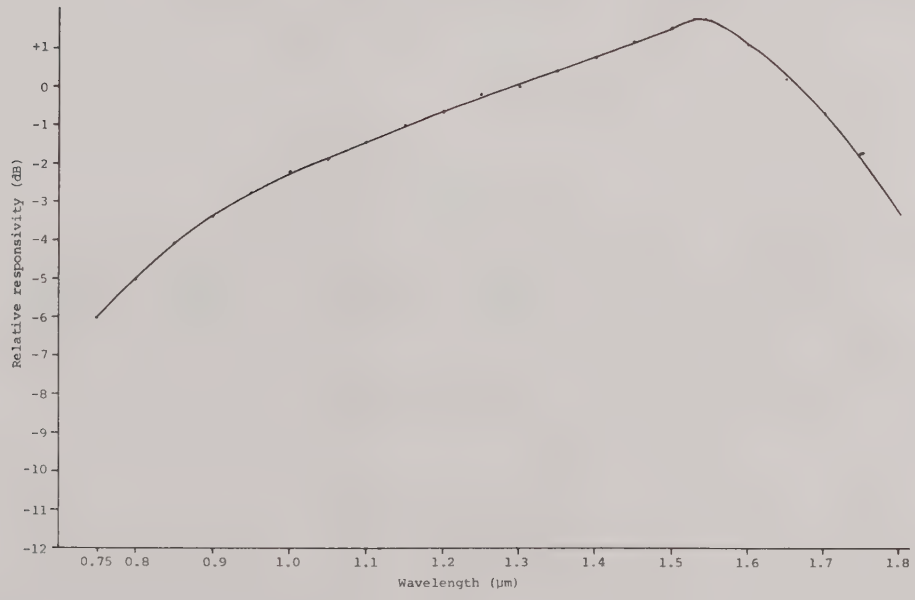


(B) MA96A/MA913A

Fig. 6-1 Wavelength Responsivity of Sensor



(C) MA97B/MA911A/MA912A



(D) MA98A

Fig. 6-1 Wavelength Responsivity of Sensor (Cont'd)

6.2 Equipment Required

Note:

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment. Satisfactory performance of alternate items should be verified prior to use.

Environmental range requirements of measurement standards and support equipment:

Temperature 25°C Relative humidity 63%

Dust ≤ 1 million/1 cu ft. (0.5 μm dust)

Table 6-2 Equipment Required

Item	Generic Term	Minimum Use Specification	Calibration Equipment MFG. MODEL/OPTIONS
T1.2.1	Xenon Lamp	° 15.3 $(mW/cm^2)/10^4$ lux	U1-501C + Xe500W
T1.2.2	Monochromator	° Grating area 30 x 30 mm ° Resolution 5 Å ° Wavelength Repeatability ≤ 10 Å	MC-10N
T1.2.3	Reference Power Meter and Sensor	° Reference Sensor Wavelength Characteristic Within ±0.5 dB	ML93B MA911A MA97B MA912A MA98A MA913A
T1.2.4	LD Light Source	° Wavelength 1.3 μm ±0.02 μm ° Output -3 ±1 dBm ° Short Stability ≤0.02 dB	MG97B

Table 6-2 Equipment Required (Cont'd)

Item	Generic Term	Minimum Use Specification	Calibration Equipment MFG. MODEL/OPTIONS
T1.2.5.	Optical Attenuator	° Wavelength 1.3 μm band ° Maximum Attenuation 65 dB Error ±1 dB (at 0, 10 dB, 20 dB step) ±2 dB (at 30, 40 dB step) ±2.5 dB (at 50 dB step) ° Insertion loss ≦3.5 dB	MN95B
T1.2.6	Voltmeter (VDC)	° Measuring Range ±1.00000 ° Accuracy ±(0.01 + 0.005)% of value	HP 3490A
T1.2.7	LD Light Source	° Wavelength 0.85 μm ±0.01 ° Output -3 ±1 dBm ° Short Stability ≦0.02 dB	MG94B
T1.2.8	Dummy Fiber	° Optical loss ≦10 dB ° Numerical Aperture 0.11 ±0.03 ° Absolute Core Diameter 26 ±3 μm	FMC-03 (FUJIKURA)

Table 6-2 Equipment Required (Cont'd)

Item	Generic Term	Minimum Use Specification	Calibration Equipment MFG. MODEL/OPTIONS
T1.2.9	Optical Attenuator	° Wavelength 0.85 µm band ° Maximum Attenuation 65 dB Error ±1 dB (at 0, 10 dB, 20 dB step) ±2 dB (at 30, 40 dB step) ±2.5 dB (at 50 dB step) ° Insertion loss ≦3.5 dB	MN95A
T1.2.10	Reference Power Meter and Sensor	Indication error ≦ ±0.1 dB	MA95A MA96A ML93B
T1.2.11	Optical Standard Power Meter	° Measuring Range -20 dBm to +20 dBm ° Accuracy Within ±2% of value (at 0.25 to 12 µm)	LPM-202 (NIHON KOSHUHA)
T1.2.12	LD Light Source	° Wavelength 0.85 µm ±0.01 µm ° Output > +10 dBm ° Short Stability ≦ 0.1 dB	
T1.2.13	LD Light Source	° Wavelength 1.3 µm ±0.02 µm ° Output > +10 dBm ° Short Stability ≦ 0.1 dB	

6.3 Preliminary Operation

(1) Turn on the power of the TEST INSTRUMENT.

(2) Heat run until the light source output power stabilizes.

6.4 Calibration Procedure

6.4.1 Wavelength Range

(1) Specifications

MA95A/97B/911A/912A 0.38 μm to 1.15 μm

MA96A/98A/913A 0.75 μm to 1.8 μm

(2) Setup

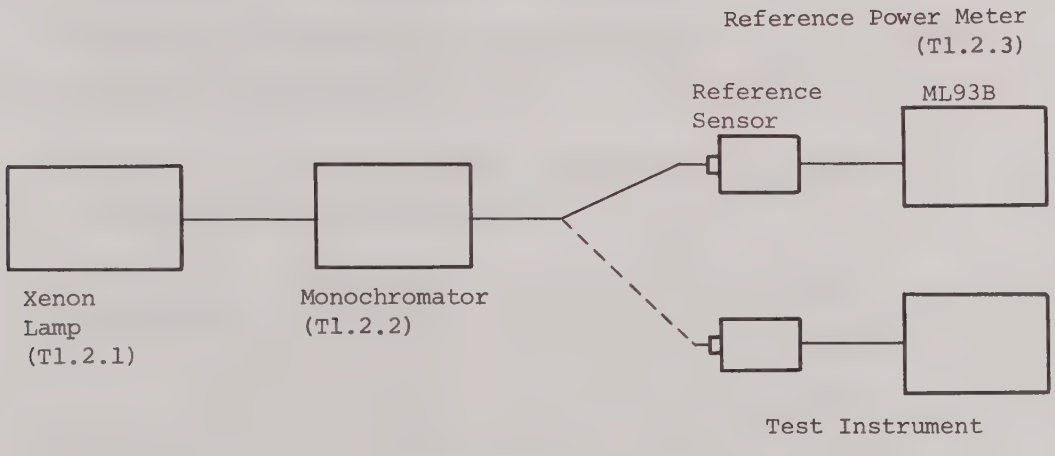


Fig. 6-2 Wavelength Range Test

(3) Procedures

(i) Connect the monochromator output to the reference sensor.

(ii) Set the monochromator to 0.38 μm.

(iii) Read the reference power meter indication.

(iv) Next, connect the monochromator output to the test instrument sensor.

(v) Read the test instrument indication.

(vi) Calculate the difference between the reference power meter indication and the test instrument indication.

(vii) Calculate the relative wavelength characteristic at 0.38 μm according to the following equation.

Wavelength characteristic of test instrument sensor at 0.38 μm is as D dB:

$$D\ (dB) = \{C - (A - B)\}\ (dB)$$

A: Result at step (3)

B: Result at step (5)

C: Wavelength characteristic of reference sensor at 0.38 μm (relative sensitivity which the value at 0.85 μm is reference)

(viii) Make this measurement from 0.38 to 1.15 μm or 0.75 to 1.8 μm in 50 nm steps as described in steps (i) to (vii) above.

(ix) For the MA95A/97B/911A/912A Sensor, the wavelength characteristic at 0.38 to 1.15 μm should be -13 dB or greater. For the MA96A/98A/913A Sensor, the wavelength characteristic at 0.75 to 1.8 μm should be -13 dB or greater.

6.4.2 Recorder Output

(1) Specifications

Proportional to indicated power with 1 V corresponding to full scale and 0.316 V to -5 dB in each range.

(2) Setup

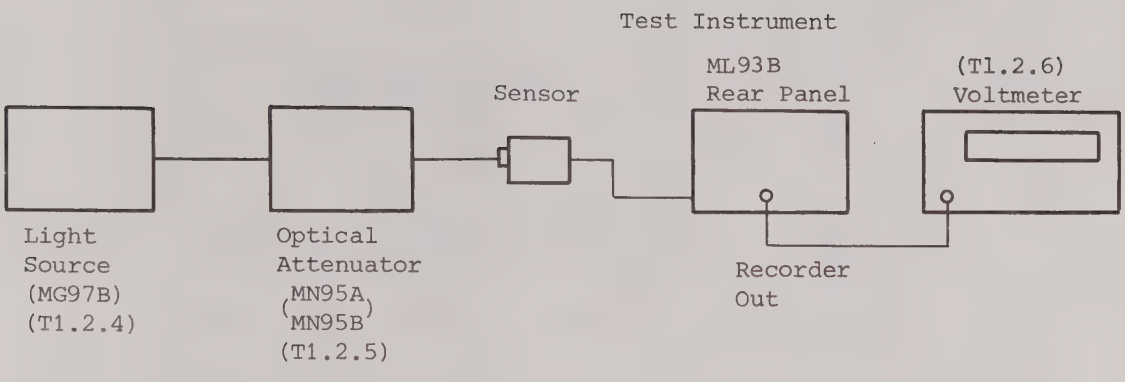


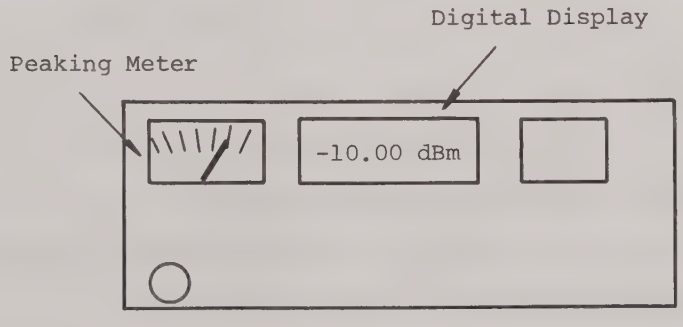
Fig. 6-3 Recorder Output Test

(3) Procedures

(i) Connect the optical attenuator output to the Sensor (MA97B, MA95A, MA96A, MA98A, MA911A, MA912A, or MA913A).

(ii) Connect the test instrument recorder output to a voltmeter.

(iii) Set the peaking meter of the test instrument to indicate the position shown as the following figure.



(iv) At full scale, the voltmeter meter reading is 1 V and when the optical input is dropped 5 dB (level lowered 5 dB by using the optical attenuator), the voltmeter reading is 0.316 V ±5%.

6.4.3 Power Measuring Range

(1) Specifications

Model	Sensor	Measuring Range
ML93B	MA95A	-90 dBm to 0 dBm (at 0.85 µm)
	MA96A	-80 dBm to 0 dBm (at 1.3 µm)
	MA97B	-65 dBm to +10 dBm (at 0.85 µm)
	MA98A	-40 dBm to +10 dBm (at 1.3 µm)
	MA911A/ MA912A	-65 dBm to +10 dBm (at 0.85 µm)
	MA913A	-50 dBm to 0 dBm (at 1.3 µm)

(2) Setup

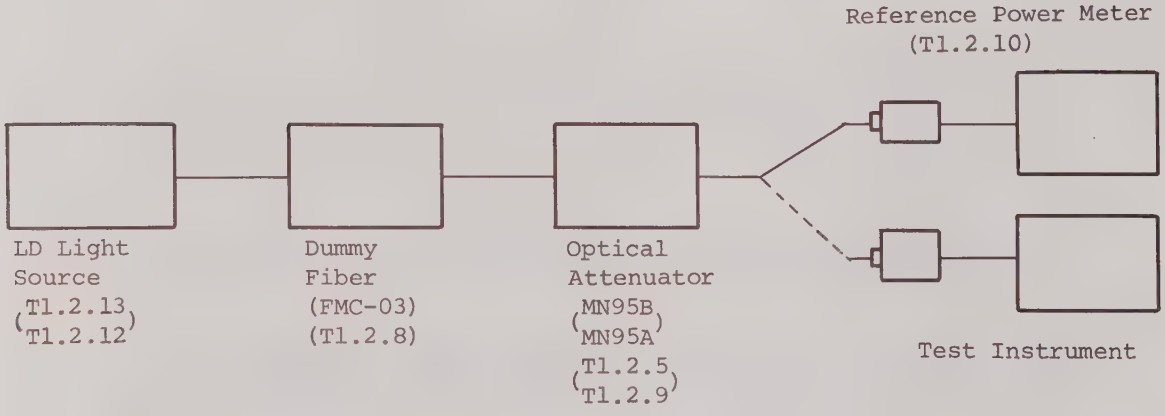


Fig. 6-4 Power Measuring Range Test

(3) Procedures

(a) MA97B, MA911A, MA912A Sensors

(i) Use the 0.85 µm LD light source.

(ii) Connect the optical attenuator and reference power meter sensor.

(iii) Adjust the optical attenuator to obtain a reference power meter reading of +10.00 dBm.

(iv) Next, connect the optical attenuator and the test instrument sensor, read the indication at this time, and compare it to +10.00 dBm. The indicated value difference should be ±0.5 dB or less.

(v) Repeat steps (i) to (iv) above from 0 dBm to -60 dBm in 10 dB steps.

(vi) Next, connect the optical attenuator and reference power meter sensor and adjust the optical attenuator to obtain a reference power meter reading of -65.00 dBm.

(vii) Connect the optical attenuator and the test instrument sensor and read the indicated value of the test instrument at this time. Compare this value to -65.00 dBm. The indicated value difference should be ±1 dB or less.

(b) MA98A, MA913A Sensors

(i) Use the 1.3 μm LD light source.

(ii) Connect the optical attenuator and reference sensor.

(iii) Adjust the optical attenuator to obtain a reference power meter reading of +10.00 dBm.

(iv) Connect the optical attenuator and the test instrument sensor, read the indication at this time, and compare it to +10.00 dBm. The indicated value difference should be ±0.5 dB or less.

(v) Repeat steps (i) to (iv) above from 0 dBm to -30 dBm in 10 dB steps.

(vi) Next, connect the optical attenuator and reference sensor and adjust the optical attenuator to obtain an indication of -40.00 dBm.

(vii) Connect the optical attenuator and test instrument sensor and read the indicated value. Compare this value to -40.00 dBm. The indicated value difference should be ±1 dB or less.

(c) MA95A Sensor

(i) Use the 0.85 μm LD light source.

(ii) Connect the optical attenuator and reference power meter sensor.

(iii) Adjust the optical attenuator to obtain a reference power meter reading of 0.00 dBm.

(iv) Next, connect the optical attenuator and test instrument sensor. Read the indicated value and compare it to 0.00 dBm. The indicated value difference should be ±0.5 dB or less.

(v) Repeat steps (i) to (iv) from -10 dBm to -80 dBm in 10 dB steps.

(vi) Next, connect the optical attenuator and the reference sensor and adjust the optical attenuator to obtain a reference power meter reading of -90.00 dBm.

(vii) Connect the optical attenuator and the test instrument sensor and read the indicated value. Compare this value to -90.00 dBm. The indicated value difference should be ±1 dB or less.

(d) MA96A Sensor

(i) Get a 1.3 μm LD light source.

(ii) Connect the optical attenuator and reference power meter sensor.

(iii) Adjust the optical attenuator to obtain a reference power meter reading of 0.00 dBm.

(iv) Next, connect the optical attenuator and the test instrument sensor. Read the indicated value and compare it to 0.00 dBm. The indicated value difference should be ±0.5 dB or less.

(v) Repeat steps (i) to (iv) from -10 dBm to -70 dBm in 10 dB steps.

(vi) Next, connect the optical attenuator and the reference power meter sensor and adjust the optical attenuator to obtain a reference power meter reading of -80.00 dBm.

(vii) Connect the optical attenuator and the test instrument sensor and read the indicated value. Compare this value to -80.00 dBm. The indicated value difference should be ±1 dB or less.

6.4.4 Accuracy

(1) Specifications

Model	Sensor	Accuracy
ML93B	MA95A MA97B MA911A MA912A	±5% (at -10 dBm, 0.85 μm, 25°C)
	MA96A MA98A MA913A	±5% (at -10 dBm, 1.3 μm, 25°C)

(2) Setup

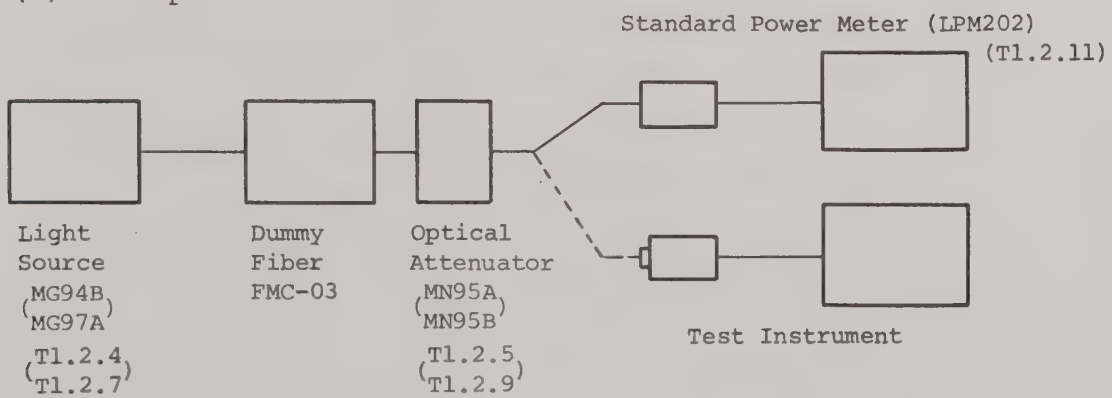


Fig. 6-5 Accuracy Measuring Test

(3) Procedures

The standard power meter must be a power meter with an accuracy of 2% of the official standard. The sum of the error with this standard power meter from the official standard and the error with the test instrument from this standard power meter must be within ±5%. However, measurements must be made under input level -10 dBm, measurement wavelength of 0.85 μm or 1.3 μm, and ambient temperature 25°C.

(a) MA95A/97B/MA911A/912A Sensor

(i) Use MG94B as the light source.

(ii) Make the measurements in a room with the ambient temperature maintained at 25°C ±2°C.

(iii) Connect the optical attenuator to the standard power meter (LPM202) sensor.

(iv) Adjust the optical attenuator to obtain an indicated value of -10.00 dBm.

(v) Next, connect the optical attenuator and the test instrument sensor (MA95A/MA97B/MA911A/MA912A) and read the indicated value.

(vi) The reading at this time should be -10.0 ±0.2 dBm.

(b) MA96A/98A/913A Sensor

(i) Use MG97A as the light source.

(ii) Make the measurements in a room with the ambient temperature maintained at 25°C ±2°C.

(iii) Connect the optical attenuator and the standard power meter (LPM202) sensor.

(iv) Adjust the optical attenuator to obtain an indicated value of -10.00 dBm.

(v) Next, connect the optical attenuator and the test instrument sensor (MA96A/MA98A/MA913A) and read the indicated value.

(vi) The reading at this time should be -10.0 ±0.2 dBm.

6.5 Test Performance Sheet

The test performance sheets were made after careful inspection of your instrument.

Specification items other than the following were also checked and found to be correct.

DATE _____

TEST NO. _____

OPERATOR _____

TEMP _____

RELATIVE HUMIDITY _____

TESTED BY _____

ITEM 1 WAVELENGTH RANGE

SPECIFICATIONS

MA95A/97B/911A/912A 0.38 μm to 1.15 μm

MA96A/98A/913A 0.75 μm to 1.8 μm

RESULT (MA95A/97B/MA911A/912A)

WAVELENGTH (μm)	RELATIVE RESPONSIVITY (dB)
0.38	
0.45	
0.50	
0.55	
0.60	
0.65	
0.70	
0.75	
0.80	
0.85	
0.90	
0.95	
1.00	
1.05	
1.10	
1.15	

Note: Reference Wavelength 0.85 μm

RESULT (MA96A/98A/913A)

WAVELENGTH (μm)	RELATIVE RESPONSIVITY (dB)
0.75	
0.80	
0.85	
0.90	
0.95	
1.00	
1.05	
1.10	
1.15	
1.20	
1.25	
1.30	
1.35	
1.40	
1.45	
1.50	
1.55	
1.60	
1.65	
1.70	
1.75	
1.80	

Note: Reference Wavelength 1.3 μm

ITEM 2 RECORDER OUTPUT

SPECIFICATIONS

Proportional to indicated power with 1 V corresponding to full scale and 0.316 V to -5 dB, in each range.

RESULT

Optical Input	Recorder Output (V)
Full scale, in each range	
5 dB lower from full scale	

ITEM 3 POWER MEASURING RANGE

SPECIFICATIONS

MA95A	-90 dBm to 0 dBm	(at 0.85 μm)
MA96A	-80 dBm to 0 dBm	(at 1.3 μm)
MA97B	-65 dBm to +10 dBm	(at 0.85 μm)
MA98A	-40 dBm to +10 dBm	(at 1.3 μm)
MA911A/MA912A	-65 dBm to +10 dBm	(at 0.85 μm)
MA913A	-50 dBm to 0 dBm	(at 1.3 μm)

RESULT

MA95A

Optical Input (dBm)	Measured Value (dBm)
0	
-10	
-20	
-30	
-40	
-50	
-60	
-70	
-80	
-90	

MA96A

Optical Input (dBm)	Measured Value (dBm)
0	
-10	
-20	
-30	
-40	
-50	
-60	
-70	
-80	

MA97B

Optical Input (dBm)	Measured Value (dBm)
+10	
0	
-10	
-20	
-30	
-40	
-50	
-60	
-65	

MA98A

Optical Input (dBm)	Measured Value (dBm)
+10	
0	
-10	
-20	
-30	
-40	

MA911A/MA912A

Optical Input (dBm)	Measured Value (dBm)
+10	
0	
-10	
-20	
-30	
-40	
-50	
-60	
-65	

MA913A

Optical Input (dBm)	Measured Value (dBm)
0	
-10	
-20	
-30	
-40	
-50	

ITEM 4 ACCURACY

SPECIFICATION

MODEL	SENSOR	SPECIFICATION
ML93B	MA95A MA97B MA911A MA912A	±5% (at -10 dBm, 0.85 µm)
	MA96A MA98A MA913A	±5% (at -10 dBm, 1.3 µm)

RESULT

MODEL	SENSOR	MEASURED VALUE
ML93B	MA95A MA96A MA97B MA98A MA911A MA912A MA913A	

SECTION 7

CALIBRATION AND ADJUSTMENT

7.1 Introduction

This section describes the method of calibration and adjustment, and general maintenance of the ML93B. Table 7-1 shows the method of general maintenance, and Table 7-2 shows the instruments required for calibration and adjustment.

Table 7-1 General Maintenance

Check	Period	Procedure
Dirt	◦ Before storing for an extended period of time	Wipe off with industrial cleaning solvent
Dust, etc.	◦ When used in a dusty environment ◦ When dirt is noticeable	Remove the cover and blow out with compressed air
Lubrication	Unnecessary	
Loose knobs screws	When found	Retighten

Table 7-2 Instruments Required for Calibration and Adjustment

Name of Instrument	Major Specifications	Required for
DC voltage standard	Output voltage: 0 to 50 V Resolution : 1 mV	Power source amplifier section of the ML93B
Oscilloscope	Frequency range : DC to 50 MHz	Power source amplifier and Control sections of the ML93B Optical power sensor
Multimeter	Sensitivity : 1 μV Input resistance : 10 MΩ	ML93B Optical power sensor
Light source	Output : ≧-5 dB Wavelength : 0.85 μm, 1.3 μm	Optical power sensor
Optical attenuator	Attenuation : ≧60 dB Resolution : 0.01 dB	Optical power sensor
Optical power meter	Measuring range : 0 to -65 dBm Measuring wavelength : 0.85 μm, 1.3 μm	Optical power sensor

7.2 Adjustment Procedure

7.2.1 ML93B Sensitivity Adjustment Procedure

This instrument is used in conjunction with any of two types of optical power sensors which may be classified roughly as either high sensitivity optical power sensor (MA95A/96A) or high power optical power sensor (MA97B/98A/MA911A/912A/913A), and required adjustments suited for the respective use. Adjust the ML93B by the adjustment procedure shown in Table 7-3.

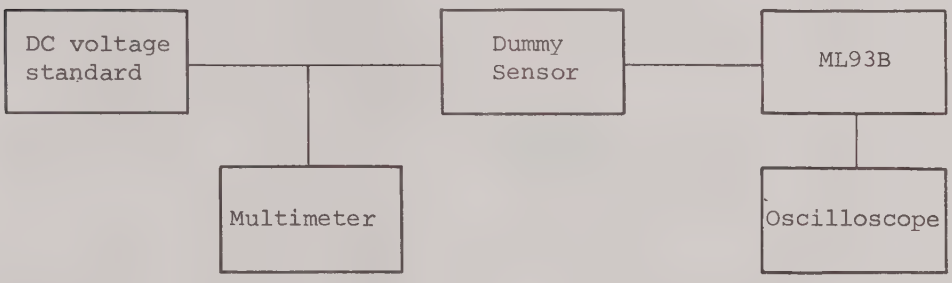


Fig. 7-1 Block Diagram for ML93B Calibration and Adjustment

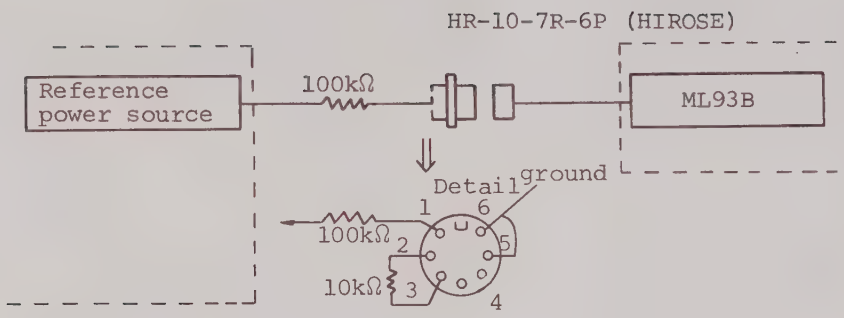
Table 7-3 Adjustment Procedure

Item	Setting	Adjustment Procedure	Remarks
Power ON	————	————	Automatic initial setting (Cal. factor shows 0.00.)
High level circuit (High level dummy sensor)	∘ Set the DC voltage standard output voltage to 0 V. Connect terminal Q13-3 to analog ground (See Fig. 8-9)	∘ Adjust R34 to make the voltage at Q13-6 0 V. ∘ Adjust R84 to make the voltage at Q25-6 0 V.	Power source, amplifier section P.C. board (Refer to Fig. 8-9)
	∘ Set the DC voltage standard output voltage to 0 V. ∘ Check the adjustment range of COARSE ZERO and set it in the vicinity of 0.	∘ Adjust R77 to make the adjustment range of COARSE ZERO -5 nW to +5 nW.	Power source, amplifier section P.C. board (Refer to Fig. 8-9)
	∘ Set the DC voltage standard output voltage to -50 V.	∘ Adjust R25 to make display +1.000 mW at the display.	Control section P.C. board (Refer to Fig. 8-6)
		∘ Adjust R85 to make recorder output voltage 1 V. ∘ Adjust R87 to make the meter needle deflect to the position shown below. 	Power source, amplifier section (Refer to Fig. 8-9)
High sensitivity circuit (High sensitivity dummy sensor)	∘ Set the DC voltage standard output voltage to 0 V.	∘ Adjust R39 and R50 to make the voltage at output terminal (red) of T1 35 to 40 Vp-p. (Tuning fork oscil-oscillation level)	Power source, amplifier section P.C. board (Refer to Fig. 8-9)

Table 7-3 Adjustment Procedure (Cont'd)

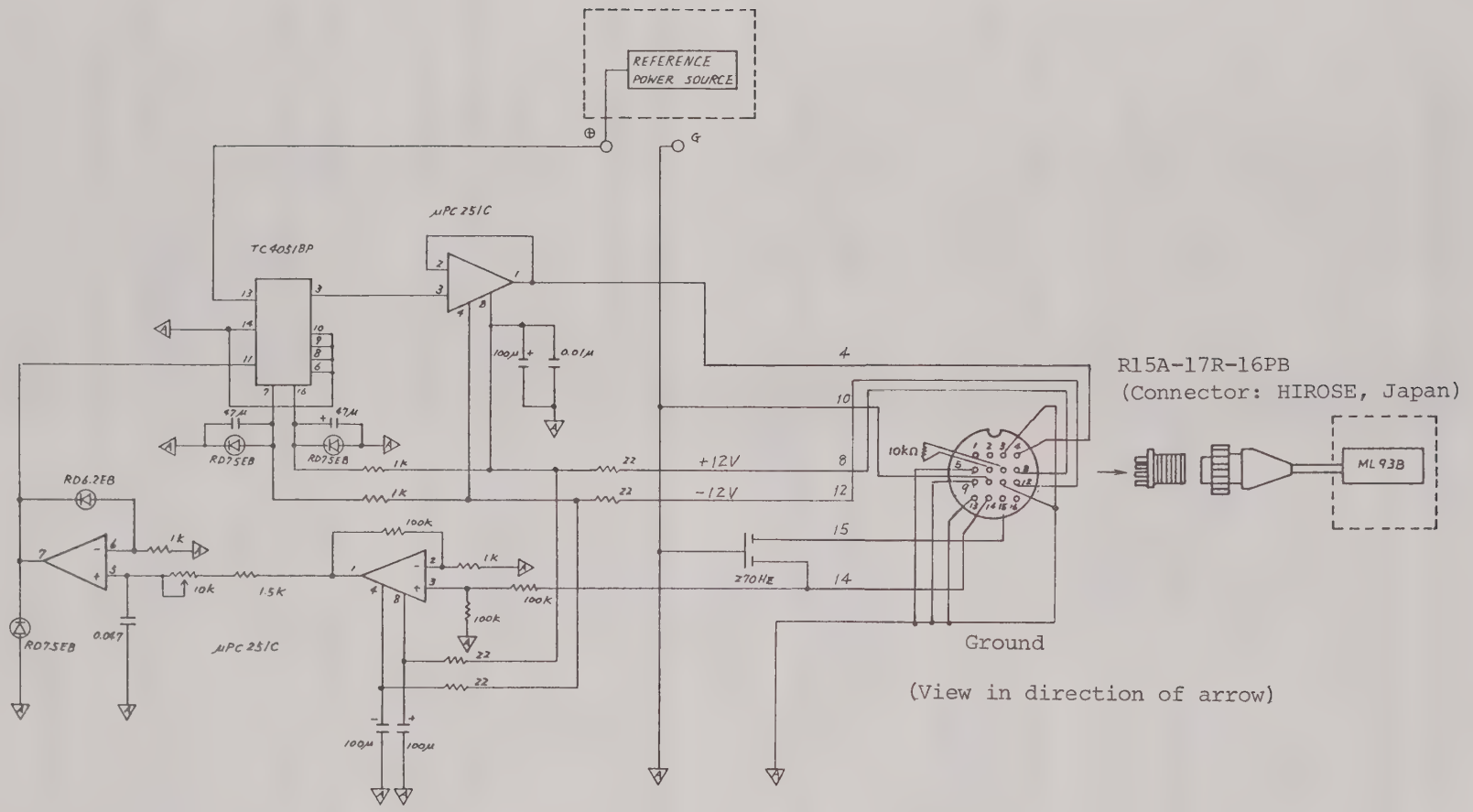
Item	Setting	Adjustment Procedure	Remarks
High sensitivity circuit (High sensitivity dummy sensor) (Cont'd)	◦ Set the DC voltage standard output voltage to 0.29 V.	◦ Use R43 to adjust the phase of the output at Q8-6.	Power source, amplifier section P.C. board (Refer to Fig. 8-9)
	◦ First set the DC voltage standard output voltage to 0.003 V and set RANGE HOLD to ON. Next set the DC voltage standard output voltage to 0 V and set MODE to W.	◦ Adjust R81 to make display 0 ±0.01 μW at the display.	Power source, amplifier section P.C. board (Refer to Fig. 8-9)
	◦ Set the DC voltage standard output voltage to 0.290 V.	◦ Adjust R108 to make display 100.0 μW at the display.	Power source, amplifier section P.C. board (Refer to Fig. 8-9)

The dummy sensor shown in Fig. 7-1 is a circuit used to provide an input corresponding to the signal from the optical power sensor to the ML93B. Fig. 7-2 shows the circuit diagram.



(a) High level Dummy Sensor (correspond to MA97B)

Fig. 7-2 Circuit Diagram of Dummy Sensor



(b) High Sensitivity Dummy Sensor (correspond to MA95A)

Fig. 7-2 Circuit Diagram of Dummy Sensor (Cont'd)

7.2.2 Optical Power Sensor Sensitivity Adjustment Procedure

(Refer to Figs. 7-3 to 7-5.)

(1) MA95A/96A

1. Connect the ML93B to the MA95A/96A and confirm that the tuning fork oscillator circuit built in the MA95A/MA96A operates normally. (If it does, the oscillation tone can be heard in the ear brought into direct contact with the MA95A/96A.)

2. As shown in Fig. 7-3, input an optical power to the reference optical power sensor and adjust the optical attenuator so that the ML93B ① indicates - 60.00 dBm.

3. Input the same optical power as in item 2 to the optical power sensor under calibration and adjust knob ① shown in Fig. 7-4 to make ML93B ② indication - 60.00 dBm.

4. Input an optical power to the reference optical power sensor and adjust the optical attenuator so that the ML93B ① indicates -30.00 dBm.

5. Input the same optical power as in item 4 to the optical power sensor under calibration and adjust knob ② shown in Fig. 7-4 to make ML93B ② indication - 30.00 dBm.

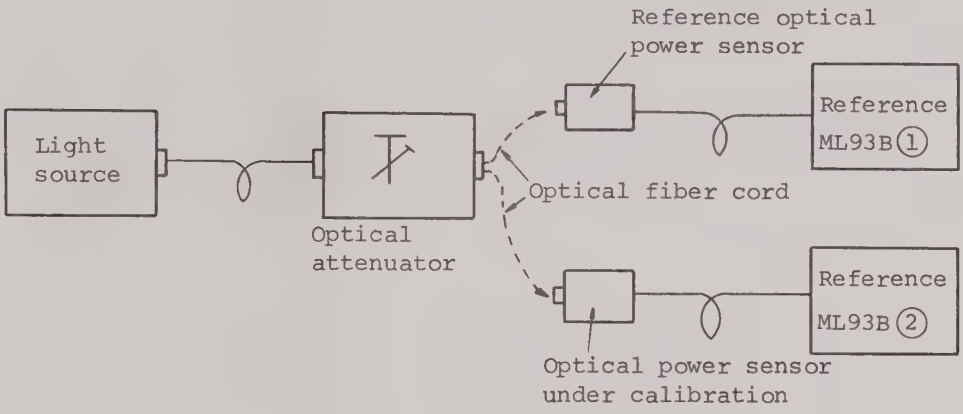
6. Input an optical power to the reference optical power sensor and adjust the optical attenuator so that the ML93B ① indicates - 10.00 dBm.

7. Input the same optical power as in item 6 to the optical power sensor under calibration and adjust knob ③ shown in Fig. 7-4 to make ML93B ② indication -10.00 dBm.

(2) MA97B/98A/911A/912A/913A

1. As shown in Fig. 7-3, input an optical power to the reference optical sensor and adjust the optical attenuator so that the ML93B ① indicates - 10.00 dBm.

2. Input the same optical power as in item 1 to the optical power sensor under calibration and adjust knob ① shown in Fig. 7-5 to make ML93B ② indication - 10.00 dBm.



NOTE: Reference ML93B ① and ML93B ② are adjusted to the same sensitivity.

Fig. 7-3 Optical Power Sensor Calibration

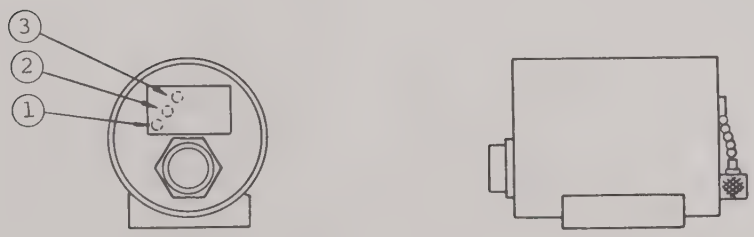


Fig. 7-4 Optical Power Sensor MA95A/96A

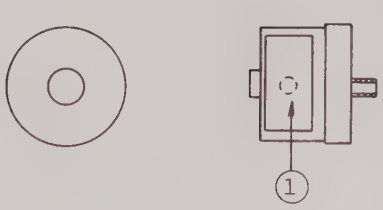


Fig. 7-5 Optical Power Sensor MA97B/98A/MA911A/913A

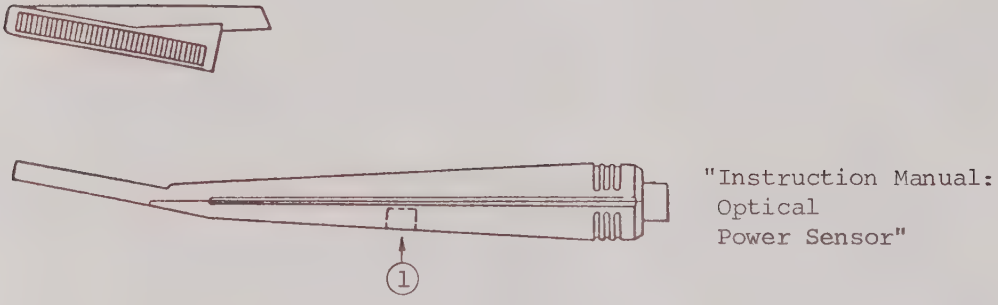


Fig. 7-6 Optical Power Sensor MA912A

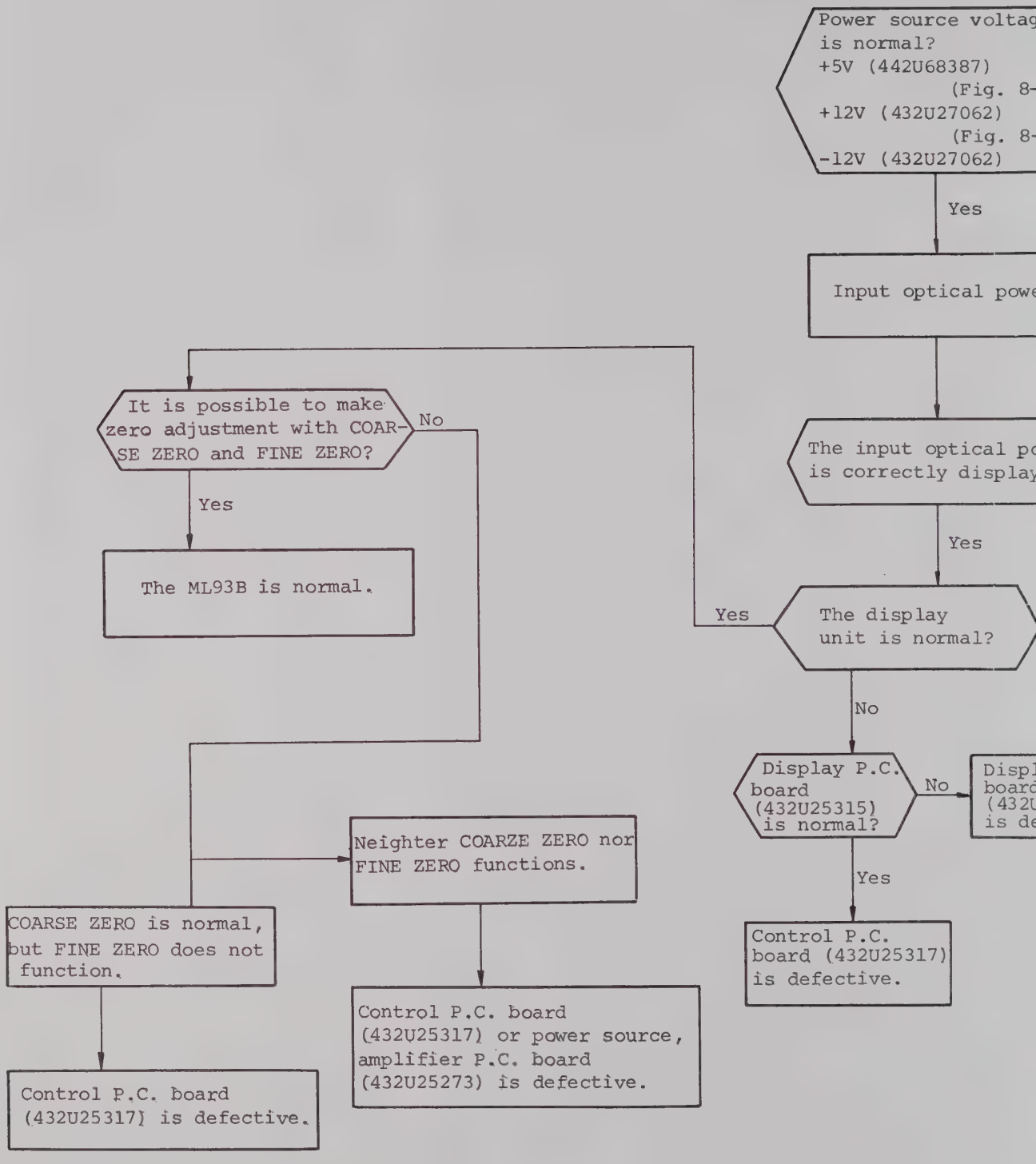
SECTION 8

TROUBLESHOOTING AND REPAIR

In the event that a trouble occurs in this instrument, find the part in which the trouble exists by the procedure shown in the troubleshooting flowcharts in the following and make repairs.

Find the defective printed circuit board by the procedure of the overall troubleshooting flowchart shown in Fig. 8-1, and repair it by reference to each printed circuit board's circuit diagram, printed circuit board components arrangement diagram and test point data (in paragraph 8.2 to 8.4).

If the control P.C. board is defective, it is necessary to replace the P.C. board. However, in the case of a simple defect, make repairs in accordance with paragraph 8.2.


Power source voltag
is normal?
+5V (442U68387)
(Fig. 8-
+12V (432U27062)
(Fig. 8-
-12V (432U27062)
Yes
Input optical powe
The input optical po
is correctly display
Yes
The display
unit is normal?
Yes
No
Display P.C.
board
(432U25315)
is normal?
No
Displ
board
(432U
is de
Yes
Control P.C.
board (432U25317)
is defective.
It is possible to make
zero adjustment with COAR-
SE ZERO and FINE ZERO?
No
Yes
The ML93B is normal.
Neighter COARZE ZERO nor
FINE ZERO functions.
COARSE ZERO is normal,
but FINE ZERO does not
function.
Control P.C. board
(432U25317) or power source,
amplifier P.C. board
(432U25273) is defective.
Control P.C. board
(432U25317) is defective.

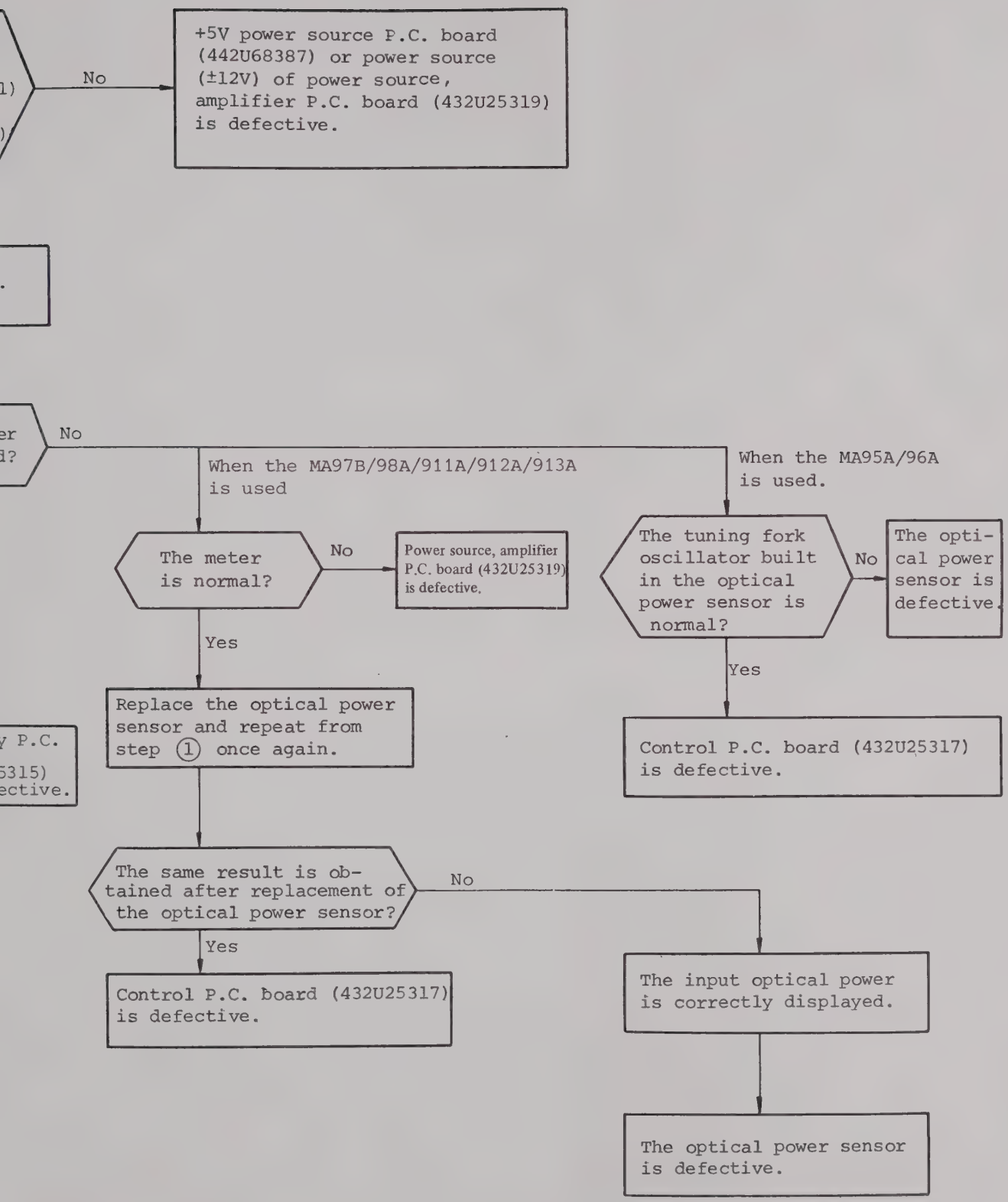
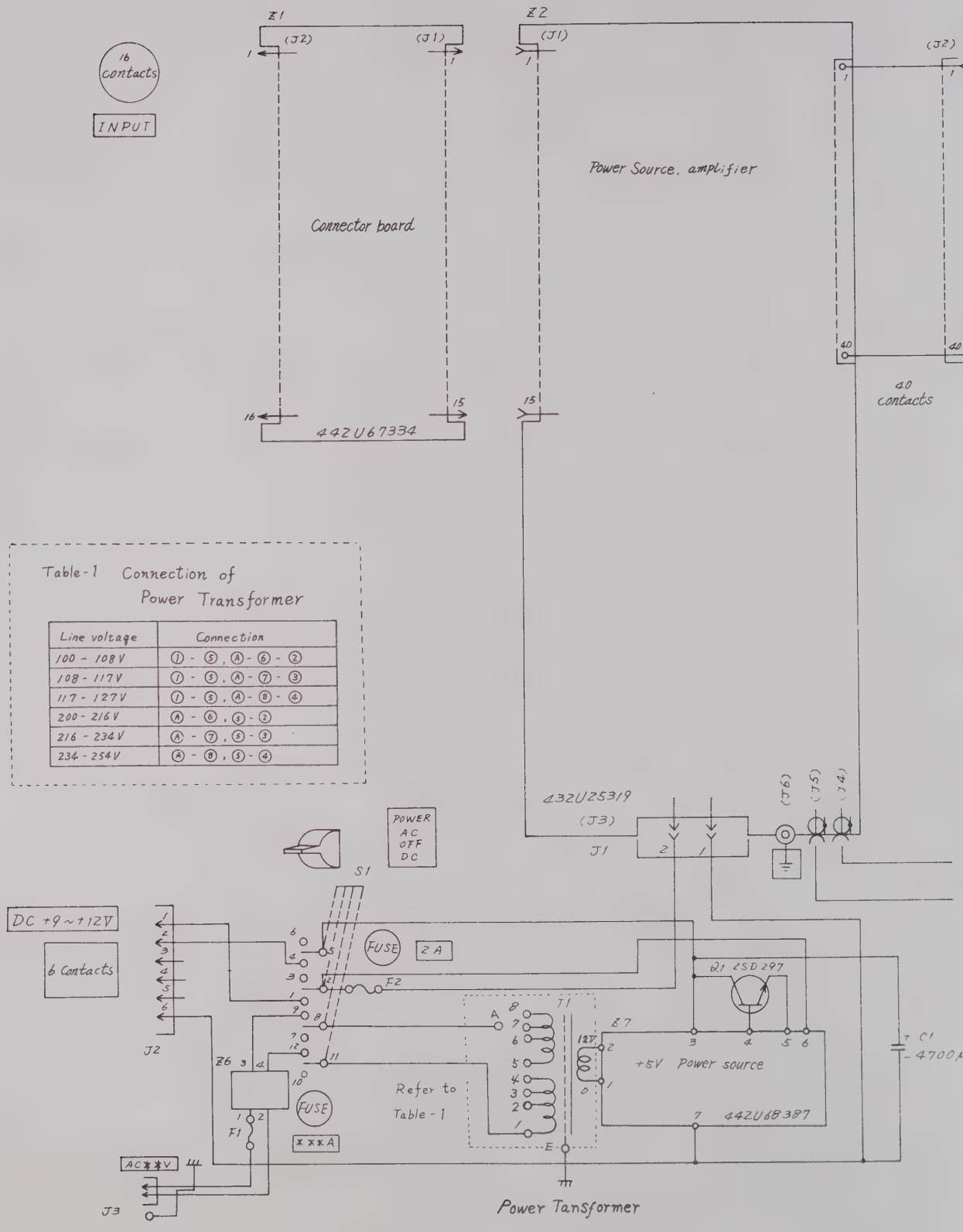

No
+5V power source P.C. board (442U68387) or power source (±12V) of power source, amplifier P.C. board (432U25319) is defective.
No
When the MA97B/98A/911A/912A/913A is used
When the MA95A/96A is used.
The meter is normal?
No
Power source, amplifier P.C. board (432U25319) is defective.
Yes
Replace the optical power sensor and repeat from step (1) once again.
The same result is obtained after replacement of the optical power sensor?
No
Yes
Control P.C. board (432U25317) is defective.
The tuning fork oscillator built in the optical power sensor is normal?
No
The optical power sensor is defective.
Yes
Control P.C. board (432U25317) is defective.
The input optical power is correctly displayed.
The optical power sensor is defective.

Fig. 8-1 Overall troubleshooting flowchart


16 contacts
INPUT
Z1
(J2)
(J1)
Connector board
442U67334
Z2
(J1)
(J2)
Power Source, amplifier
40 contacts
Table-1 Connection of Power Transformer
Line voltage | Connection
100 - 108V | ① - ⑤ , Ⓐ - ⑥ - ②
108 - 117V | ① - ⑤ , Ⓐ - ⑦ - ③
117 - 127V | ① - ⑤ , Ⓐ - ⑧ - ④
200 - 216V | Ⓐ - ⑥ , ⑤ - ②
216 - 234V | Ⓐ - ⑦ , ⑤ - ③
234 - 254V | Ⓐ - ⑧ , ⑤ - ④
432U25319
(J3)
J1
(J6)
(J5)
(J4)
POWER
AC
OFF
DC
S1
DC +9 ~ +12V
6 Contacts
J2
FUSE
2A
F2
Q1 2SD297
T1
Z7
12V
+5V Power source
442U68387
C1
4700μ
Z6
FUSE
F1
***A
AC***V
J3
Refer to Table-1
Power Tansformer

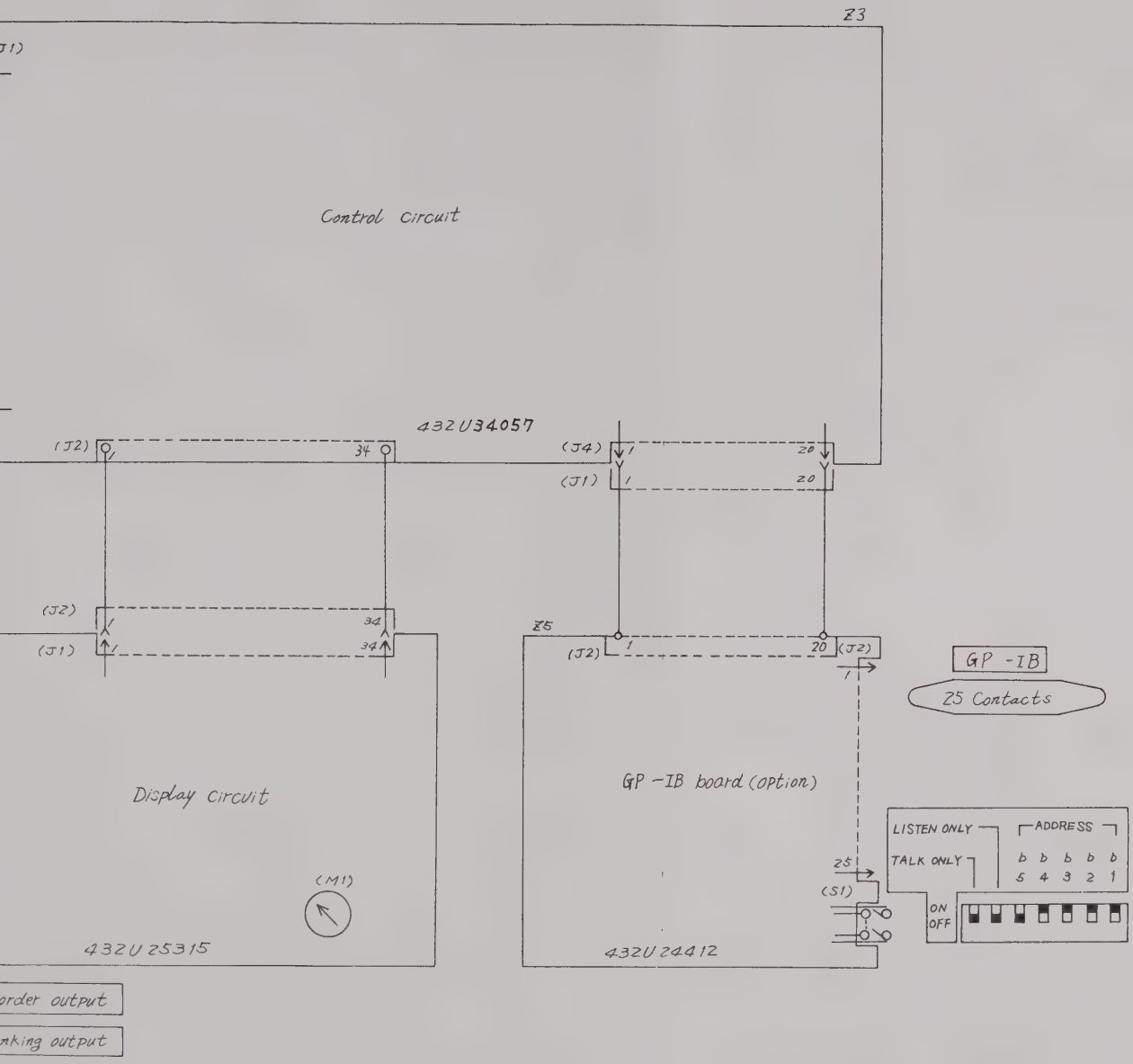
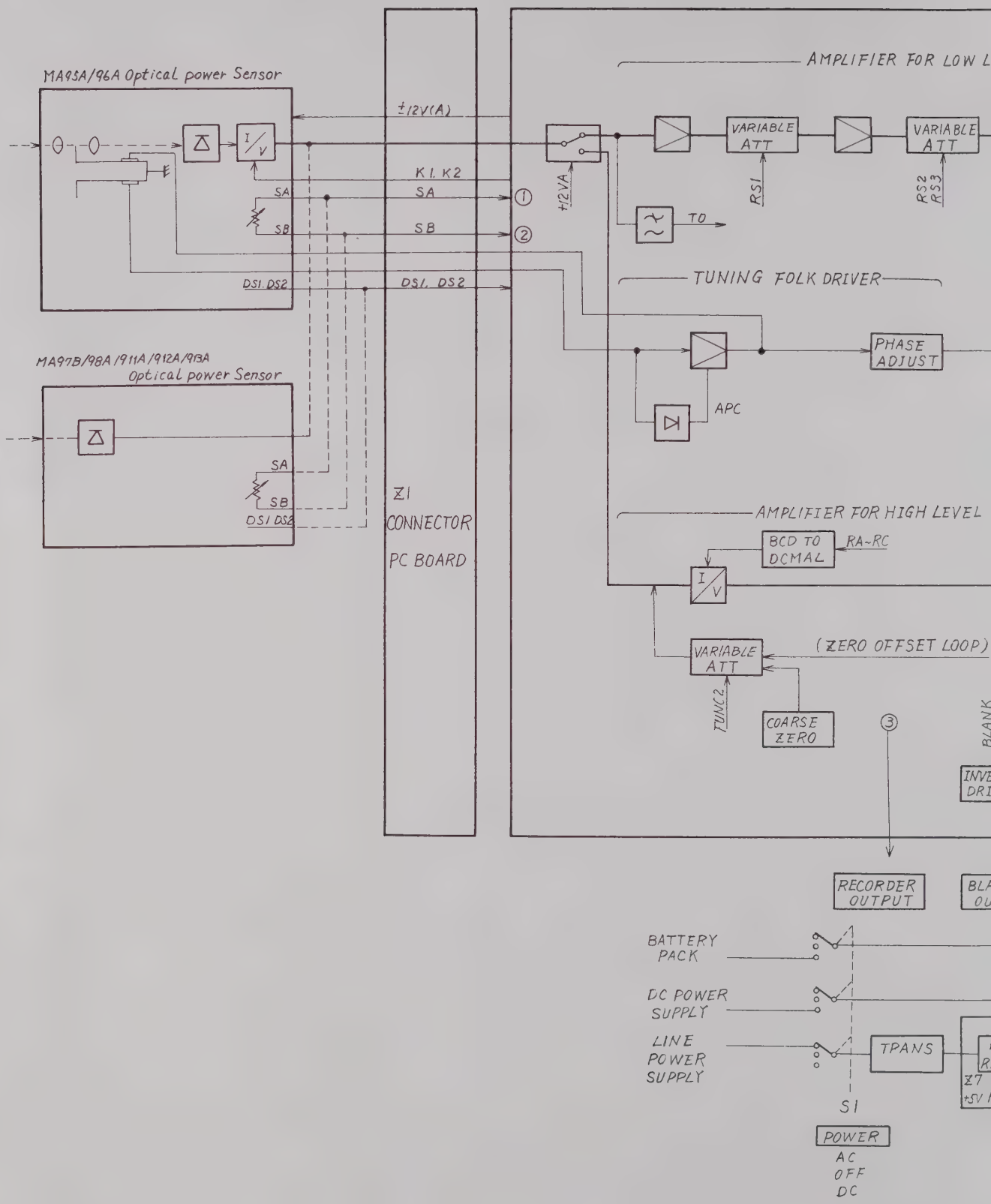


Fig. 8-2 CIRCUIT DIAGRAM OF OPTICAL POWER METER ML93B

8.2 Control P.C. Board Troubleshooting

8.2.1 Circuit Description

The control circuit employs a microprocessor to control various parts of the ML93B. Fig. 8-3 shows the block diagram and Table 8-1 shows explanation of control signals.


MA98A/96A Optical power Sensor
MA97B/98A/911A/912A/913A
Optical power Sensor
±12V(A)
K1. K2
SA
SB
DS1. DS2
SA
SB
DS1, DS2
Z1
CONNECTOR
PC BOARD
AMPLIFIER FOR LOW L
VARIABLE ATT
VARIABLE ATT
RS1
RS2
RS3
±12VA
TO
TUNING FOLK DRIVER
PHASE ADJUST
APC
AMPLIFIER FOR HIGH LEVEL
BCD TO DCMAL
RA~RC
VARIABLE ATT
(ZERO OFFSET LOOP)
TUNE2
COARSE ZERO
RECORDER OUTPUT
BATTERY PACK
DC POWER SUPPLY
LINE POWER SUPPLY
TPANS
S1
POWER
AC
OFF
DC

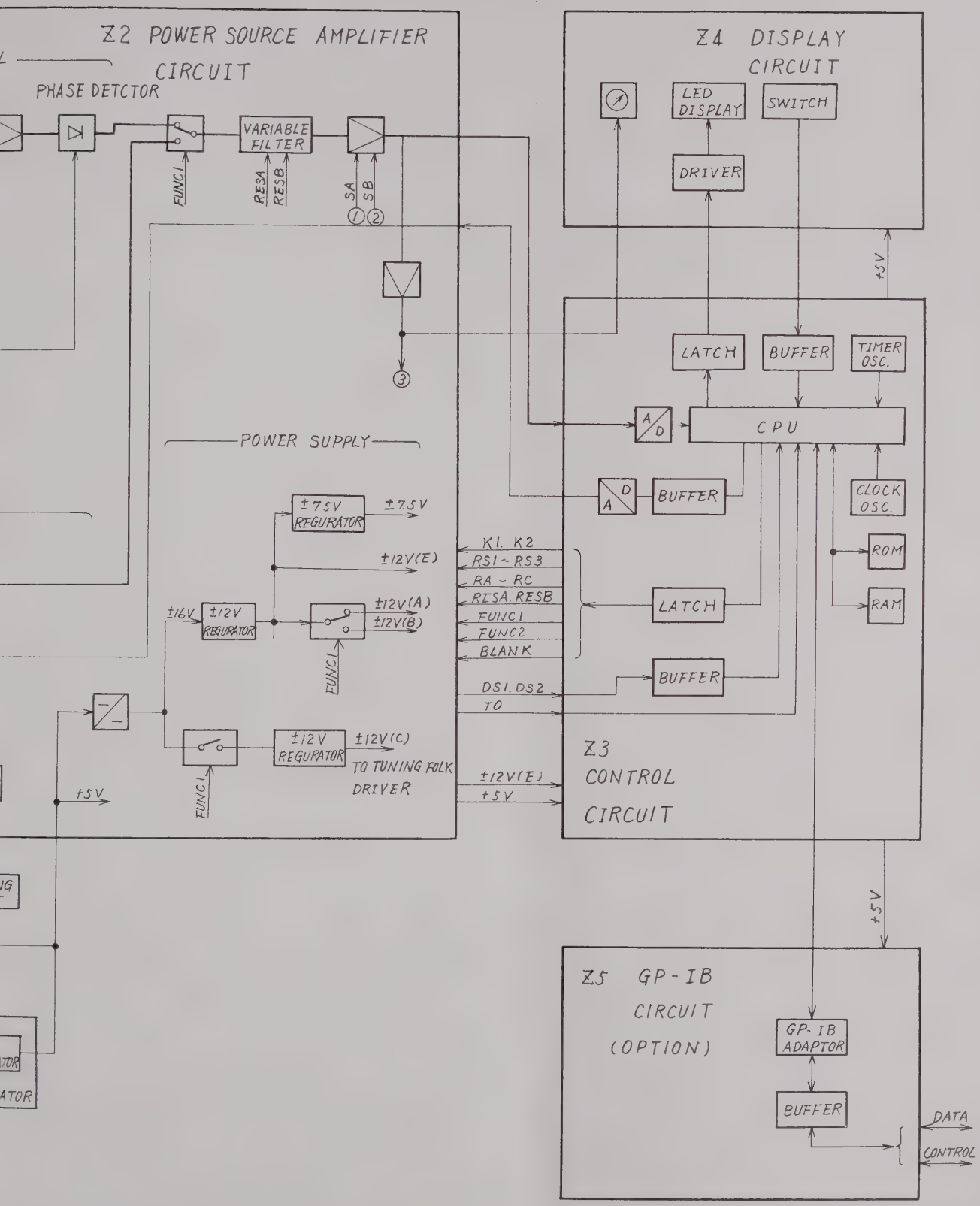


Fig. 8-3 ML93B OPTICAL POWER METER BLOCK DIAGRAM

Table 8-1 Explanation of Control Signals

Regarding range select

Name and Value of signal *	Description
K2 K1	To be used for range select of MA95A/96A
1, 0	0 to -30 dBm ranges To turn on relay K1 in the sensor MA95A/96A
0, 1	-30 to -60 dBm ranges To turn on relay K2 in the sensor MA95A/96A
1, 1	-60 to -90 dBm ranges To turn off relay K1, K2 in the sensor MA95A/96A
RS3 RS2 RS1	To be used for range select of the amplifier for low level.
1, 0, 1	0 dBm range ATT1 = 40 dB, ATT2 = 40 dB
0, 1, 1	-10 " ATT1 = 40 dB, ATT2 = 20 dB
0, 0, 1	-20 " ATT1 = 40 dB, ATT2 = 0 dB
1, 0, 1	-30 " ATT1 = 40 dB, ATT2 = 40 dB
0, 1, 1	-40 " ATT1 = 40 dB, ATT2 = 20 dB
0, 0, 1	-50 " ATT1 = 40 dB, ATT2 = 0 dB
1, 0, 0	-60 " ATT1 = 0 dB, ATT2 = 40 dB
0, 1, 0	-70 " ATT1 = 0 dB, ATT2 = 20 dB
0, 0, 0	-80 " ATT1 = 0 dB, ATT2 = 0 dB
RC RB RA	To be used for range select of the amplifier for high level.
0 0 0	+10 dB range Relay K1 in I/V circuit: ON
0 0 1	0 dB " " K2 " "
0 1 0	-10 dB " " K3 " "
0 1 1	-20 dB " " K4 " "
1 0 0	-30 dB " " K5 " "
1 0 1	-40 dB " " K6 " "
1 1 0	-50 dB " " K7 " "
1 1 1	-60 dB " " K1 K6 " : OFF
A/D REF	Reference voltage select of A/D
0	A/D input 1.2 to 0.25 V
1	A/D input 0.1 to 0.5 V

Table 8-1 Explanation of Control Signals (Cont'd)

Name and Value of Signal *	Description
TO	Auxiliary signal for range select when the MA95A/96A I/V circuit becomes saturated and no AC signal is provided.
0	MA95A/96A input value proper
1	MA95A/96A input value excessive

Regarding optical power sensor changes

Name and Value of Signal *	Description
DS2, DS1	Sensor identification signal
0, 0	MA95A
1, 1	MA96A
0, 1	MA97B/911A/912A/913A
1, 0	MA98A
FUNC 1	ZERO SET LOOP sensitivity changeover of the MA97B/98A/911A/912A/913A
0	MA97B/911A/912A/913A
1	MA98A
FUNC 2	Power source changeover and input changeover when the M95A/96A or the MA97B/98A/911A/912A/913A is connected.
0	Power source ±12V(A), ±12V(C) ON when the MA95A/96A is connected.
1	Power source ±12V(B) ON when the MA97B/98A/911A/912A/913A is connected.
+12V(A)	To turn on and off power source +12V(A) for circuit changeover at FUNC 2 and connect the input signal to amplifier high level or low level.
+12V	MA95A/96A
0V	MA97B/98A/911A/912A/913A

Table 8-1 Explanation of Control Signals (Cont'd)

Filter Circuit Changeover

Name and Value of Signal *	Description
RESB, RESA	To changeover response according to the range.
0, 0	Response 20 sec
0, 1	" 2 sec
1, 0	" 0.2 sec

Others

Name and Value of Signal *	Description
BLANK	To output ground signal from BLANKING OUTPUT during ZERO SET.
0	Other than FINE ZERO SET period
1	FINE ZERO SET period

* 1: ≧1.5 V
  0: ≦0.5 V

8.2.2 Control Circuit P.C. Board Troubleshooting Flowchart

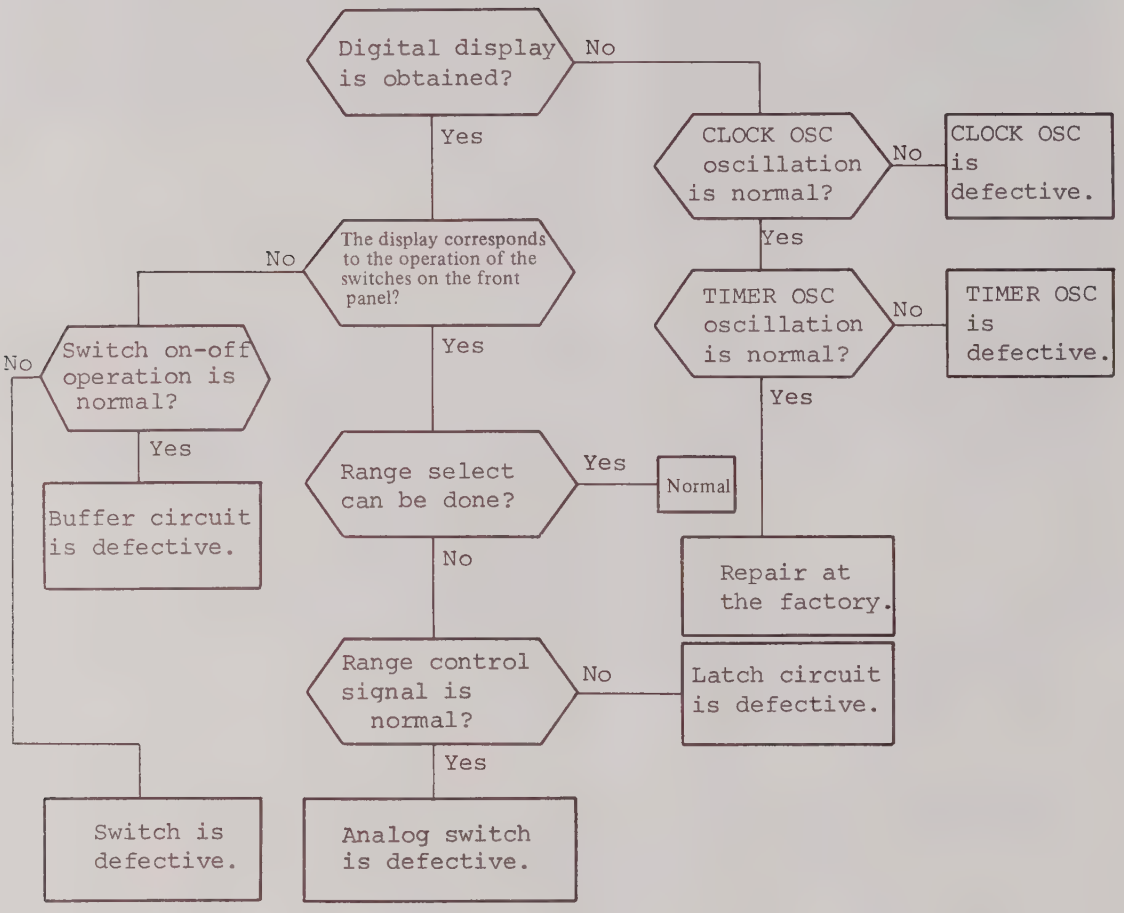
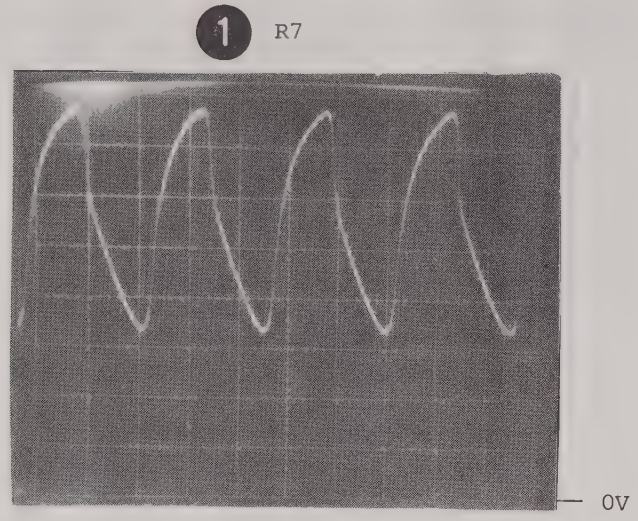


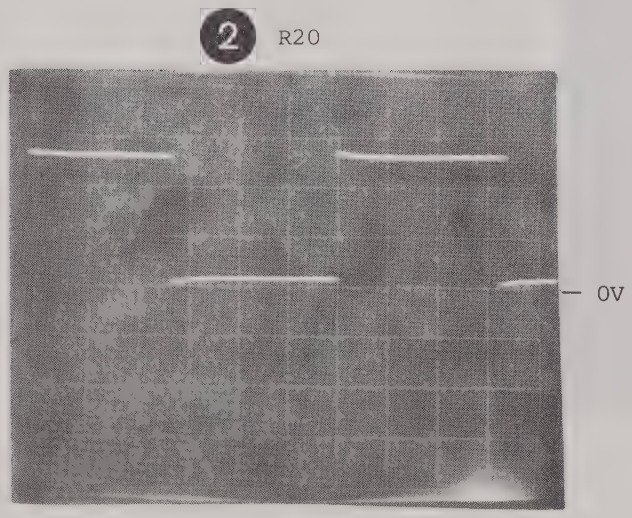
Fig. 8-4 Control Circuit P.C. Board Troubleshooting

8.2.3 Control Circuit P.C. Board Test Point Waveforms and Component Arrangement Diagrams



A/D OSC OUT

Ⓥ : 1 V/div
Ⓗ : 1 μsec/div

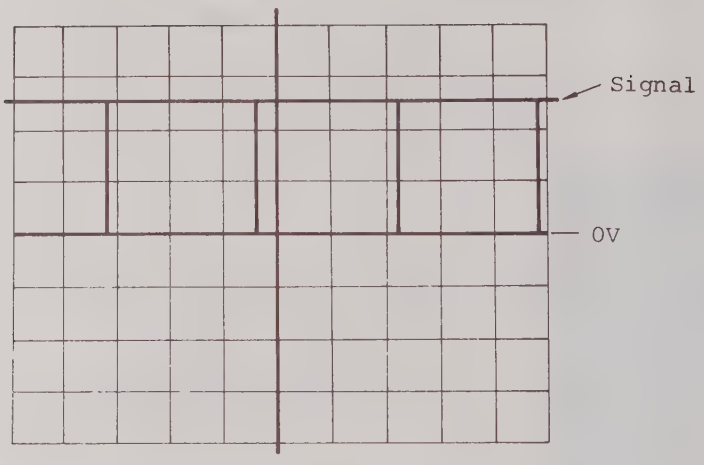


TIMER INT CLOCK

Ⓥ : 2 V/div
Ⓗ : 0.2 msec/div

Fig. 8-5 Control Circuit P.C. Board Test Point Waveforms

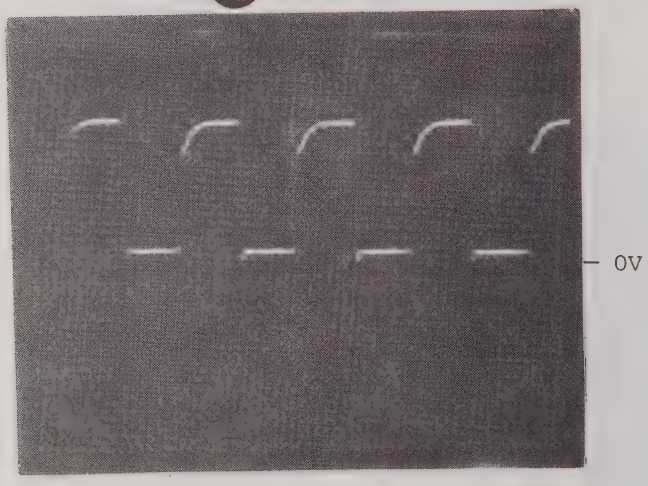
3 R14



CPU $\overline{INT}$

(V) : 2 V/div
(H) : 0.5 msec/div

4 R9



CLK

(V) : 2 V/div
(H) : 0.2 μsec/div

The above test points positions are shown in Fig. 8-6.

Fig. 8-5 (Continued)

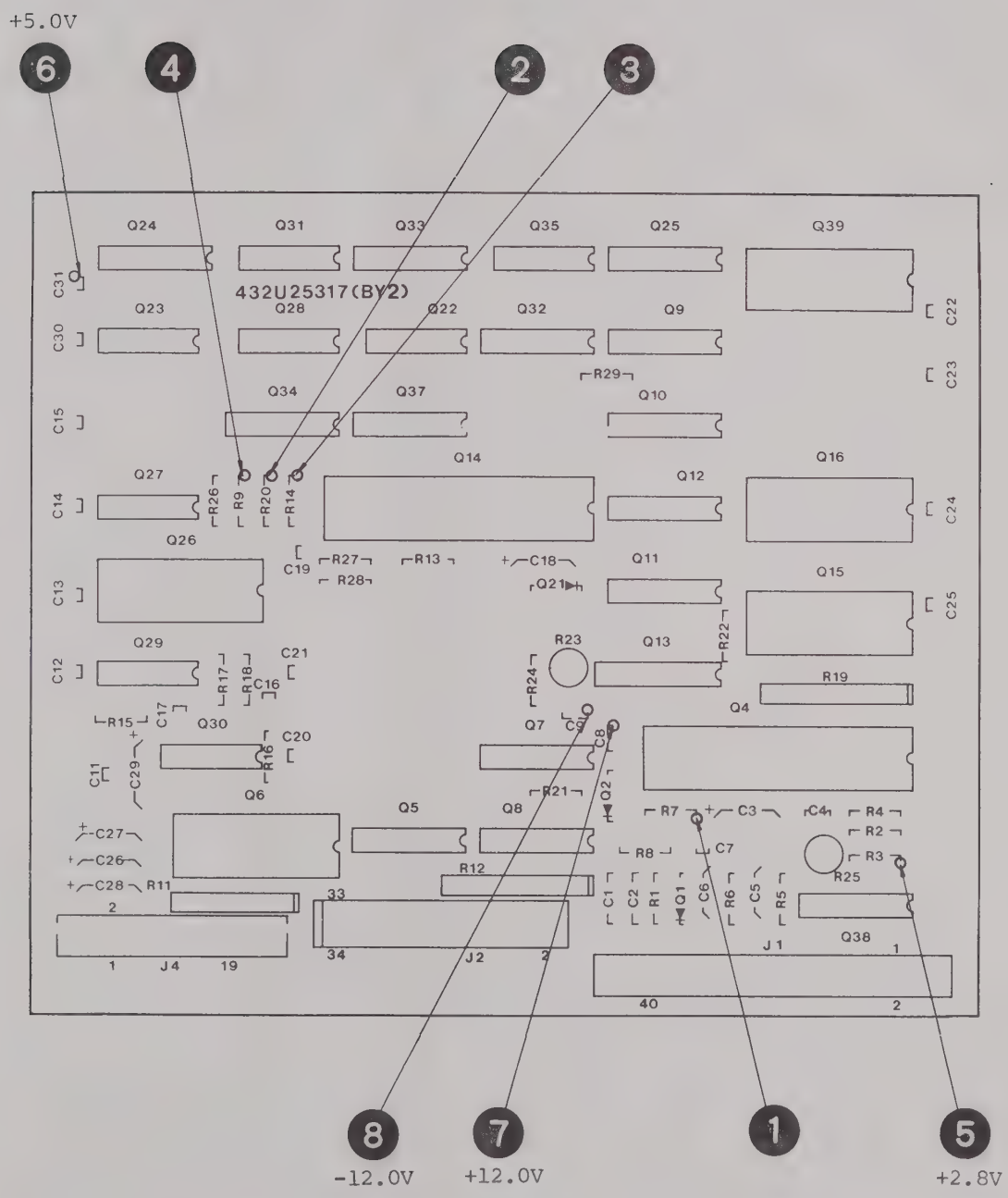
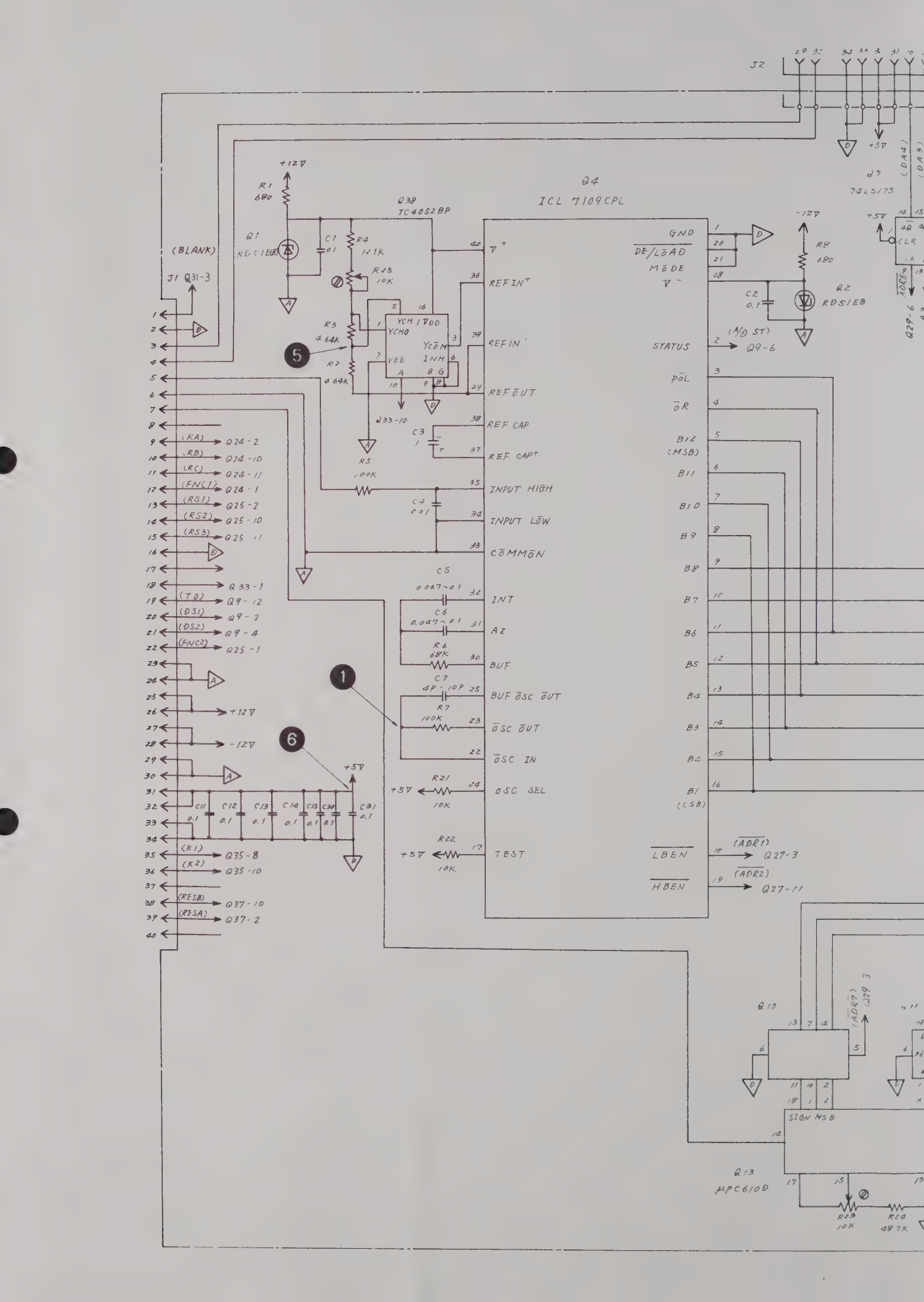


Fig. 8-6 Control Circuit P.C. Board Component Arrangement Diagram


Q4
ICL 7109CPL
Q38
TC4052BP
(BLANK)
J1 Q31-3
+12V
-12V
+5V
R1 680
R4 121K
R25 10K
R3 4.64K
R2 4.64K
R5 100K
C1 0.1
C3 1
C5 0.047~0.1
C6 0.047~0.1
R6 68K
C7 47P~10P
R7 100K
R21 10K
R22 10K
C11 0.1
C12 0.1
C13 0.1
C14 0.1
C15 0.1
C30 0.1
C31 0.1
R8 680
C2 0.1
Q2 RD5.1EB
Q1 RD5.1EB
Q5 74LS175
V+
REFIN+
REFIN-
REFOUT
REF CAP
REF CAP+
INPUT HIGH
INPUT LOW
COMMON
INT
AZ
BUF
BUF OSC OUT
OSC OUT
OSC IN
OSC SEL
TEST
V-
DE/LOAD MODE
STATUS
POL
OR
B12 (MSB)
B11
B10
B9
B8
B7
B6
B5
B4
B3
B2
B1 (LSB)
LBEN
HBEN
(ADR1)
(ADR2)
(ADR7)
SIGN MSB
Q10
Q13 μPC610D
R23 10K
R24 487K
(KA)
(KB)
(KC)
(FNC1)
(RS1)
(RS2)
(RS3)
(TD)
(DS1)
(DS2)
(FNC2)
(K1)
(K2)
(RESB)
(RESA)
Q24-2
Q24-10
Q24-11
Q24-1
Q25-2
Q25-10
Q25-11
Q33-1
Q9-12
Q9-2
Q9-4
Q25-1
Q35-8
Q35-10
Q37-10
Q37-2
Q33-10
Q9-6
Q27-3
Q27-11
Q29-6
1
5
6

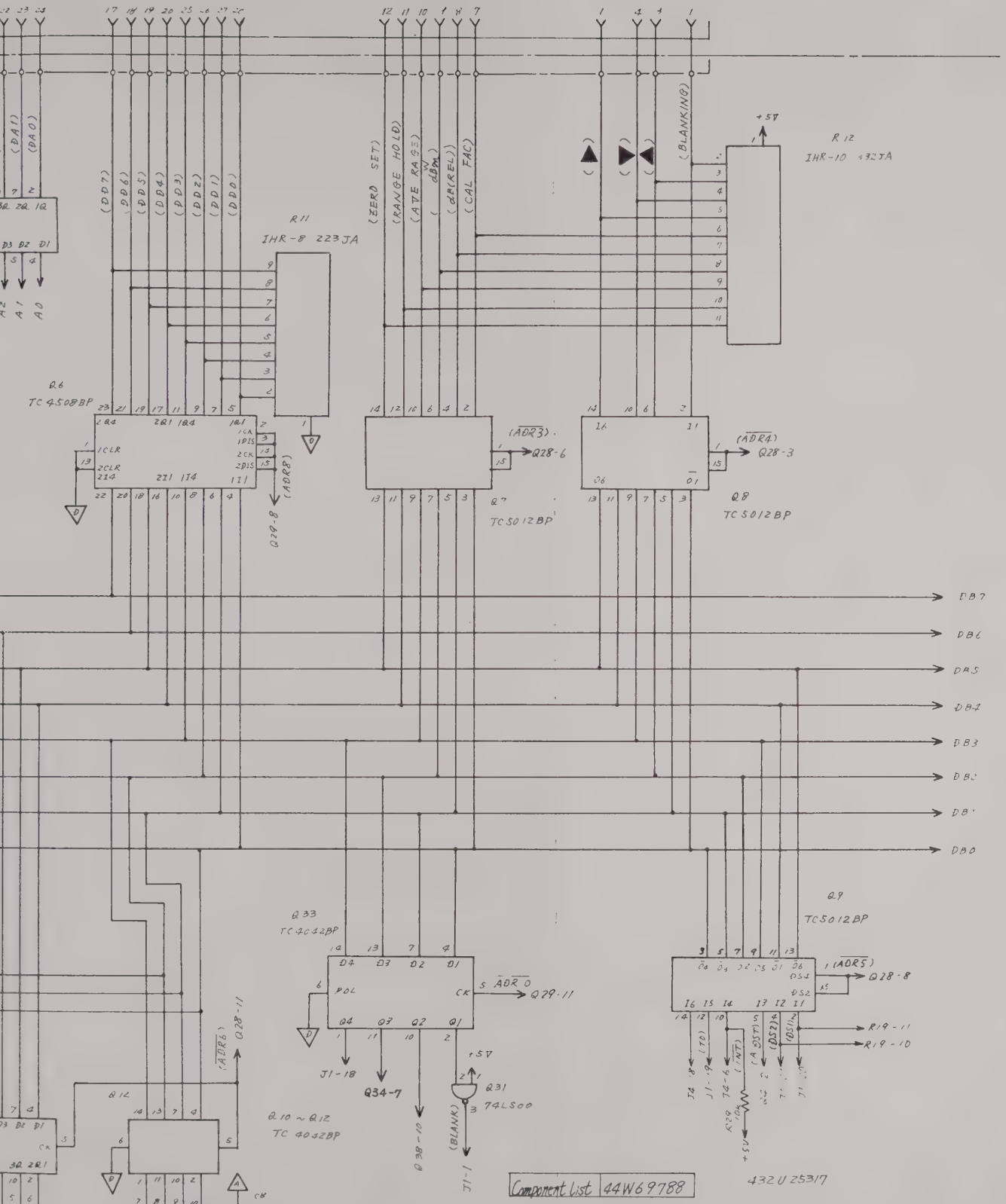
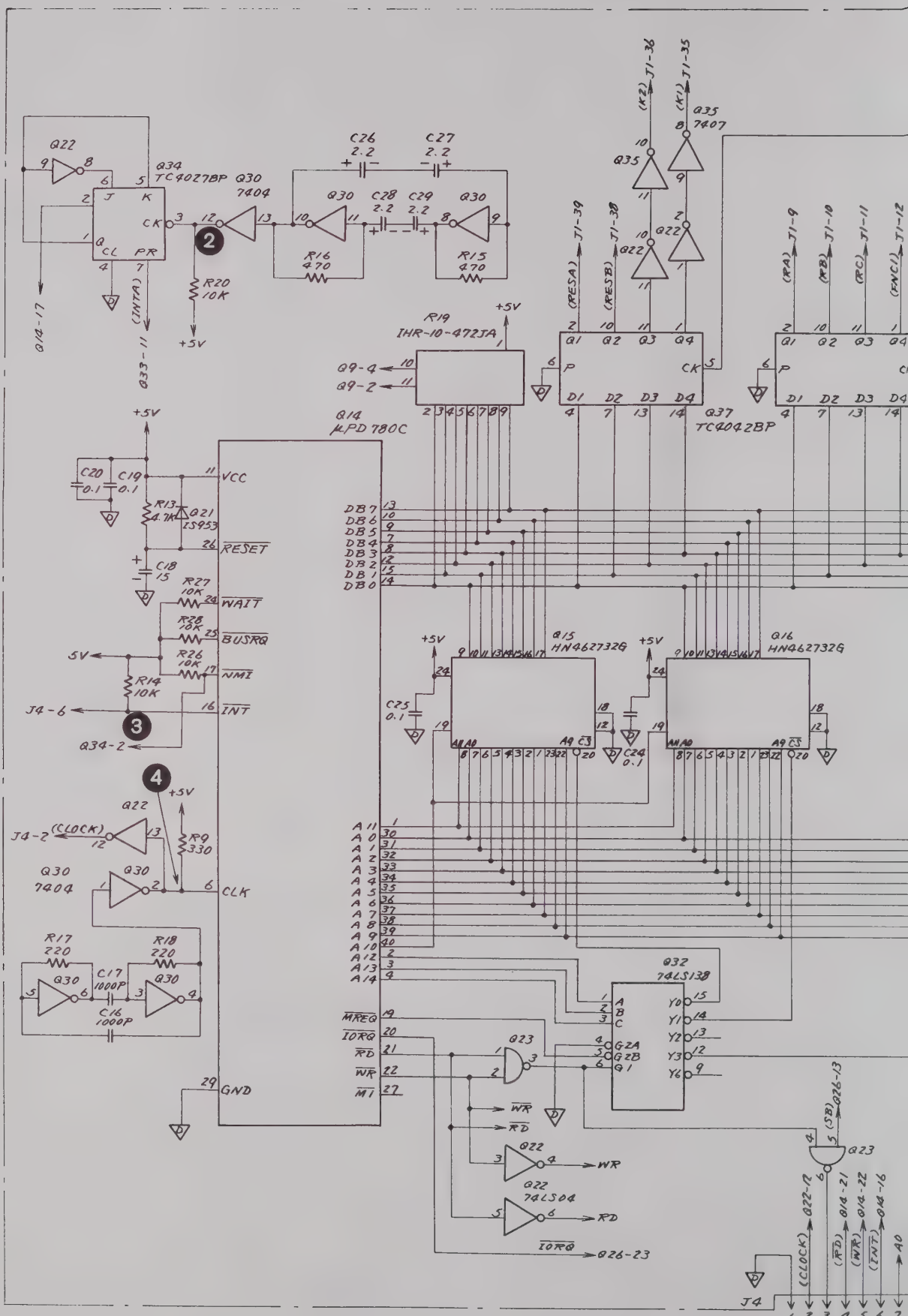


Fig. 8-7 CIRCUIT DIAGRAM OF CONTROL CIRCUIT (1/2)


Q22
Q34 TC4027BP
Q30 7404
C26 2.2
C27 2.2
C28 2.2
C29 2.2
R16 470
R15 470
R20 10K
+5V
Q14-17
Q33-11
(INTA)
(XZ) J1-36
(XY) J1-35
Q35 7407
(RESA) J1-39
(RESB) J1-38
(RA) J1-9
(RB) J1-10
(RC) J1-11
R19 IHR-10-472JA
Q9-4
Q9-2
Q37 TC4042BP
Q14 μPD 780C
VCC
C20 0.1
C19 0.1
R13 4.7K
Q21 1S953
C18 15
RESET
R27 10K
WAIT
R28 10K
BUSRQ
R26 10K
NMI
R14 10K
INT
J4-6
Q34-2
DB7
DB6
DB5
DB4
DB3
DB2
DB1
DB0
Q15 HN4627332G
Q16 HN4627332G
C25 0.1
C24 0.1
A11
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A12
A13
A14
Q22
J4-2 (CLOCK)
R9 330
Q30 7404
CLK
R17 220
R18 220
C17 1000P
C16 1000P
Q32 74LS138
MREQ
IORQ
RD
WR
M1
GND
Q23
WR
RD
Q22
Q22 74LS04
IORQ
Q26-23
Q26-13
(SB)
Q22-12
(CLOCK)
Q14-21
(RD)
Q14-22
(WR)
Q14-16
(INT)
A0
J4

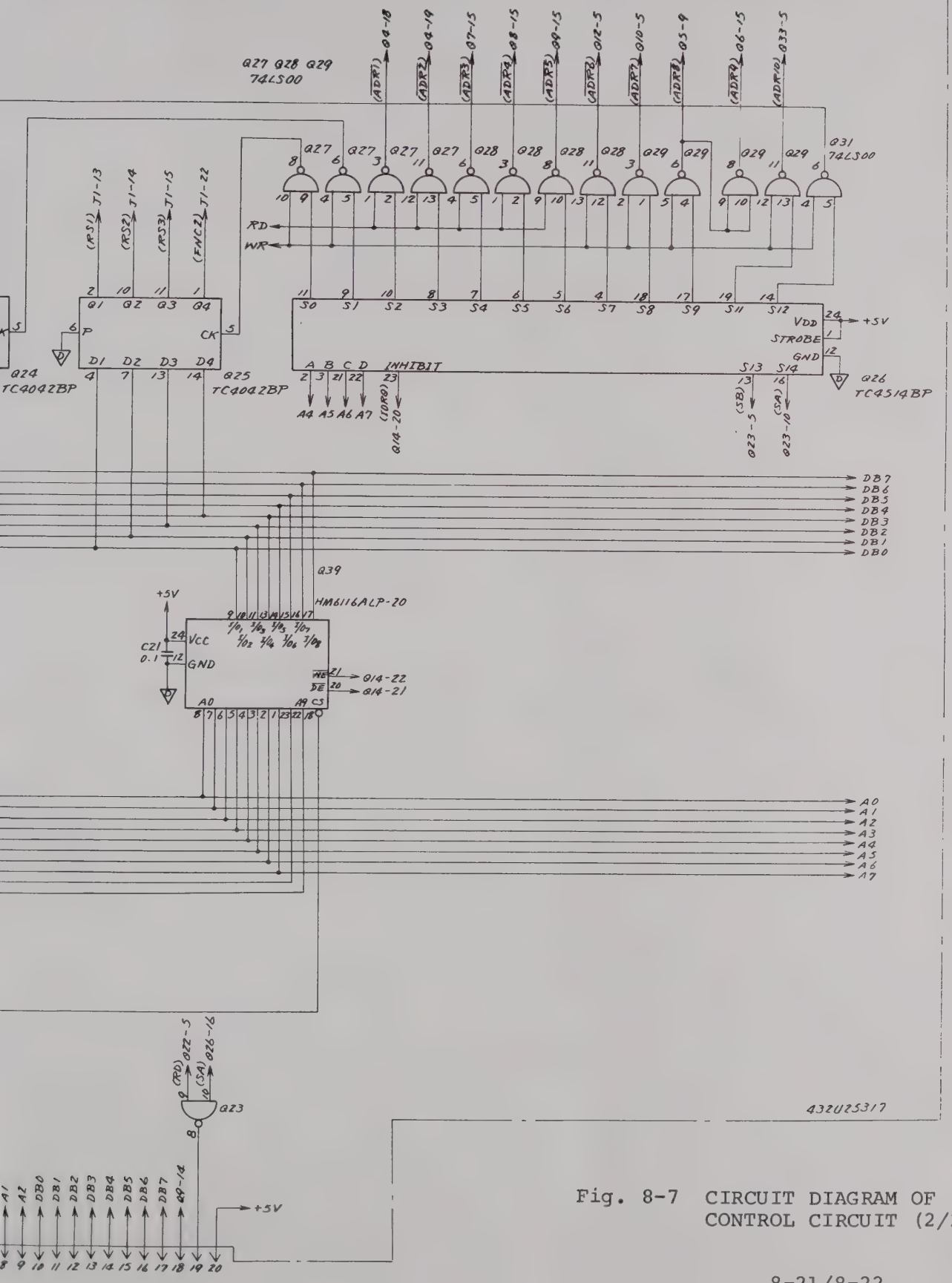
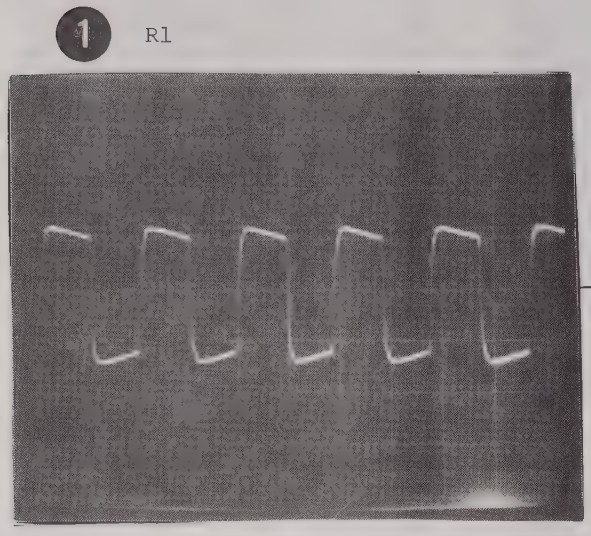


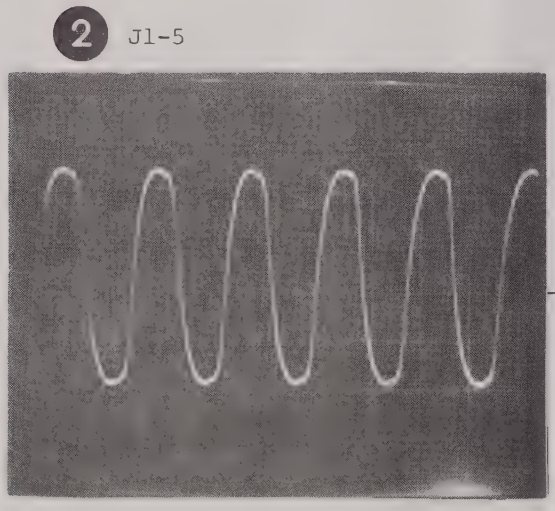
Fig. 8-7 CIRCUIT DIAGRAM OF CONTROL CIRCUIT (2/2)

8.3 Power Source, Amplifier P.C. Board



Optical power input: -30.0 dBm

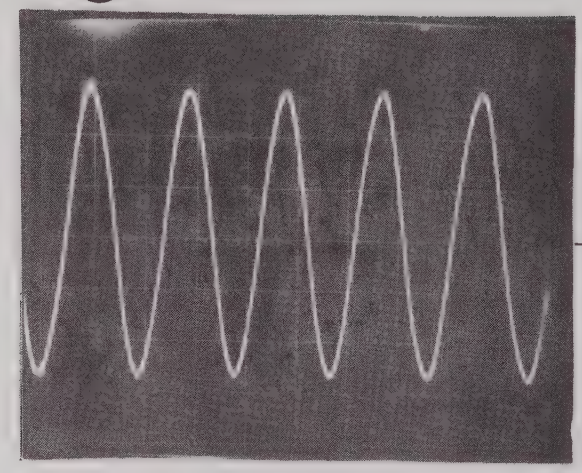
(V) : 0.5 V/div
(H) : 2 msec/div



(V) : 10 V/div
(H) : 2 msec/div

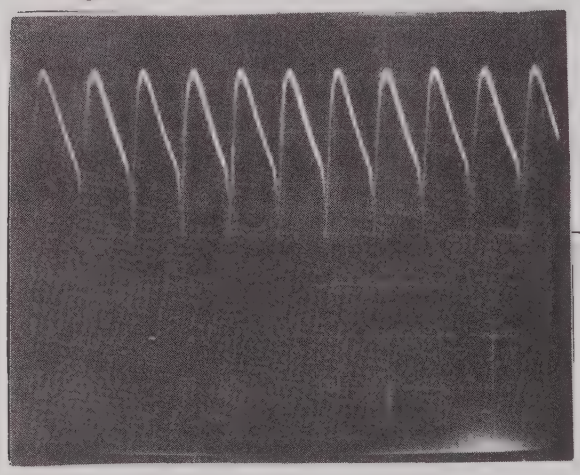
Fig. 8-8 Power Source, Amplifier P.C. Board
Test Point Waveforms

3 R46



Ⓥ : 0.2 V/div
Ⓗ : 2 msec/div

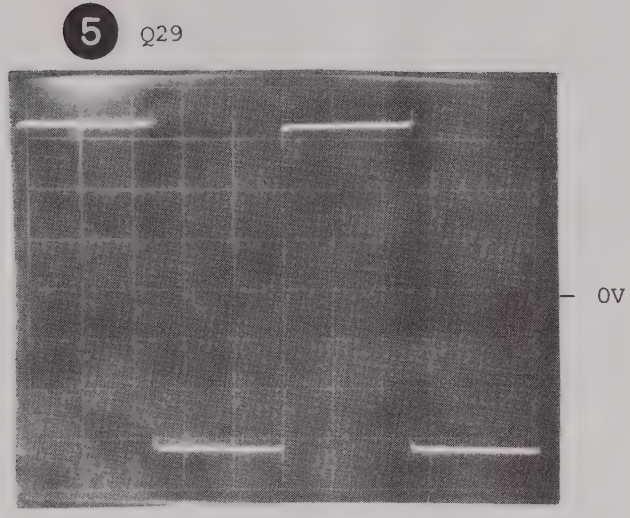
4 R25



Optical power input: -30 dBm

Ⓥ : 0.2 V/div
Ⓗ : 2 msec/div

Fig. 8-8 (Continued)



Ⓥ : 5 V div
Ⓗ : 2 msec/div

The above test points positions are shown in Fig. 8-9.

Fig. 8-8 (Continued)

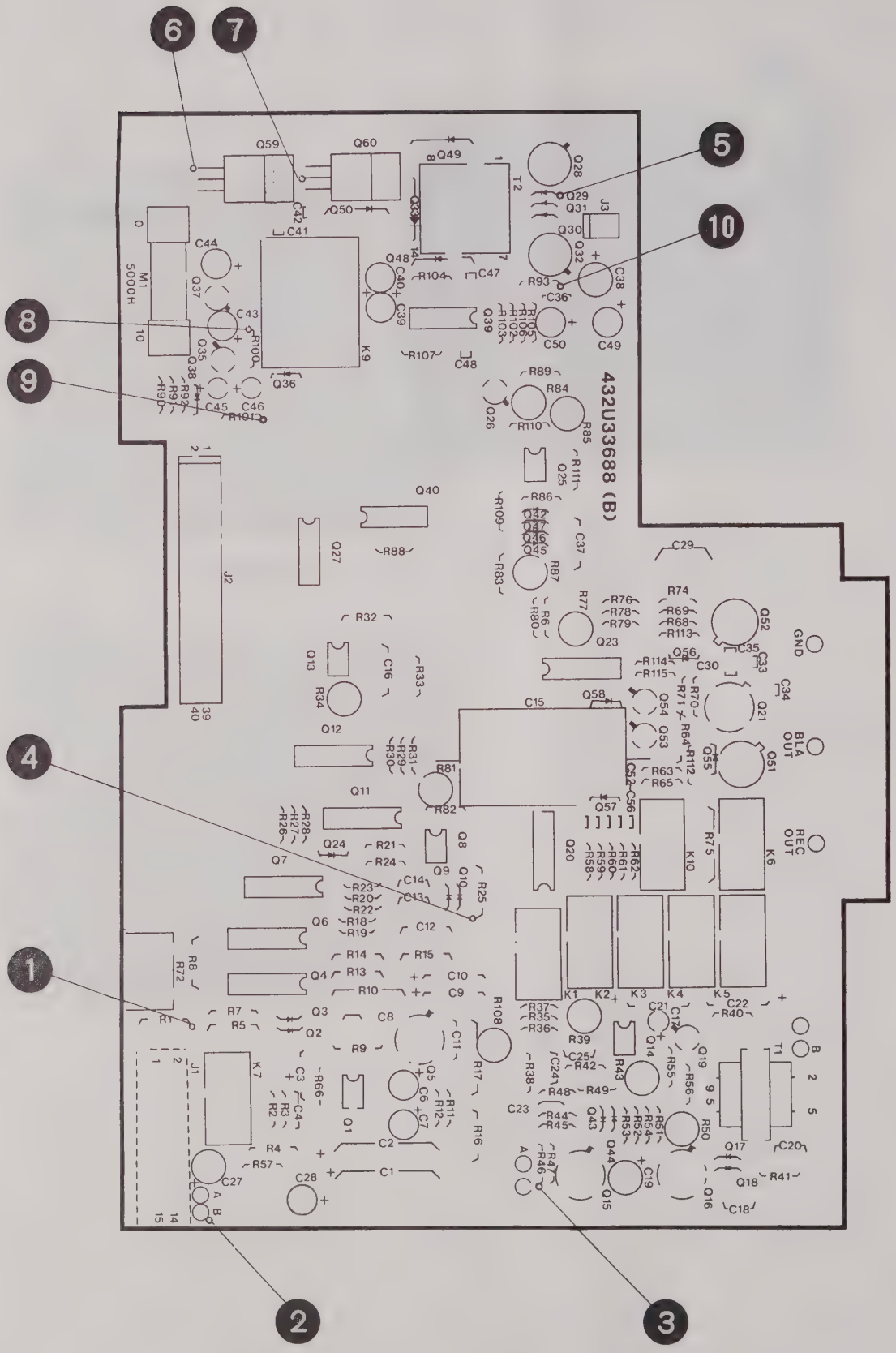
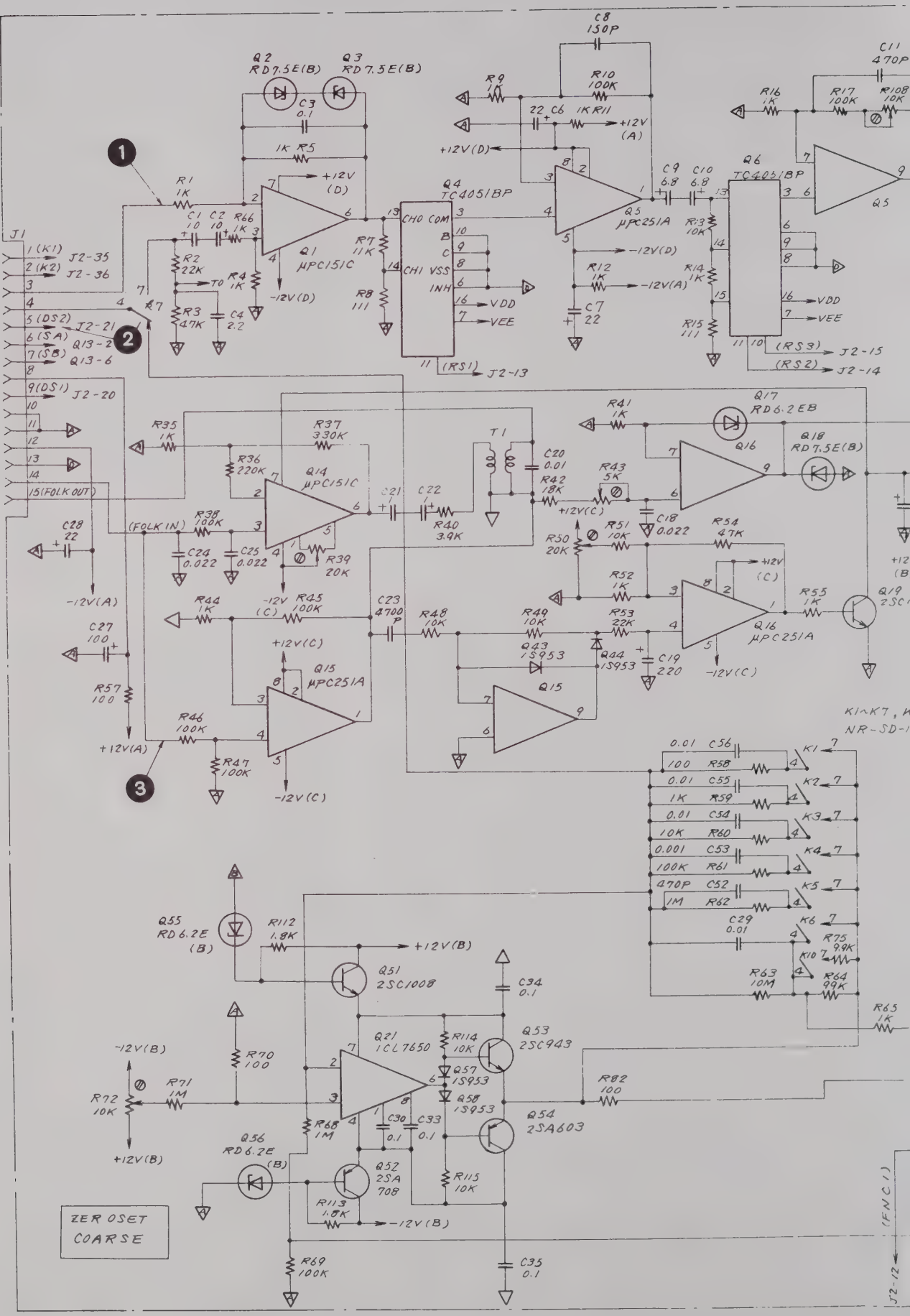


Fig. 8-9 Power Source, Amplifier P.C. Board Component Arrangement Diagram


Q2 RD7.5E(B)
Q3 RD7.5E(B)
C3 0.1
1K R5
R1 1K
+12V (D)
Q1 μPC151C
-12V(D)
C1 10
C2 10
R66 1K
R2 22K
R4 1K
R3 47K
C4 2.2
J1
1 (K1) J2-35
2 (K2) J2-36
5 (DS2) J2-21
6 (SA) Q13-2
7 (SB) Q13-6
9 (DS1) J2-20
15 (FOLK OUT)
(FOLK IN)
R7 11K
R8 111
Q4 TC4051BP
CH0 COM
CH1 VSS
INH
VDD
VEE
(RS1) J2-13
C8 150P
R9 1K
R10 100K
22 C6
1K R11
+12V (A)
+12V(D)
Q5 μPC251A
C9 6.8
C10 6.8
R12 1K
-12V(A)
C7 22
Q6 TC4051BP
R13 10K
R14 1K
R15 111
(RS3) J2-15
(RS2) J2-14
C11 470P
R16 1K
R17 100K
R108 10K
Q17 RD6.2EB
Q16
Q18 RD7.5E(B)
R41 1K
R35 1K
R37 330K
R36 220K
Q14 μPC151C
T1
C20 0.01
R42 18K
R43 5K
+12V(C)
C18 0.022
C21
C22
R40 3.9K
R38 100K
C24 0.022
C25 0.022
R39 20K
C28 22
-12V(A)
R50 20K
R51 10K
R54 47K
R52 1K
+12V (C)
R55 1K
Q19 2SC
R44 1K
-12V (C)
R45 100K
C23 4700P
R48 10K
R49 10K
R53 22K
Q43 1S953
Q44 1S953
C19 220
-12V(C)
C27 100
R57 100
+12V(A)
Q15 μPC251A
+12V(C)
R46 100K
R47 100K
-12V(C)
Q15
K1~K7, K
NR-SD-
0.01 C56
100 R58
0.01 C55
1K R59
0.01 C54
10K R60
0.001 C53
100K R61
470P C52
1M R62
K1
K2
K3
K4
K5
K6
K10
C29 0.01
R75 9.9K
R63 10M
R64 99K
R65 1K
Q55 RD6.2E (B)
R112 1.8K
+12V(B)
Q51 2SC1008
C34 0.1
Q21 ICL7650
R114 10K
Q53 2SC943
Q57 1S953
Q58 1S953
Q54 2SA603
R82 100
-12V(B)
R70 100
R71 1M
R72 10K
+12V(B)
R68 1M
C30 0.1
C33 0.1
Q56 RD6.2E (B)
Q52 2SA 708
R115 10K
R113 1.8K
-12V(B)
R69 100K
C35 0.1
ZERO SET COARSE
(FNC1)
J2-12

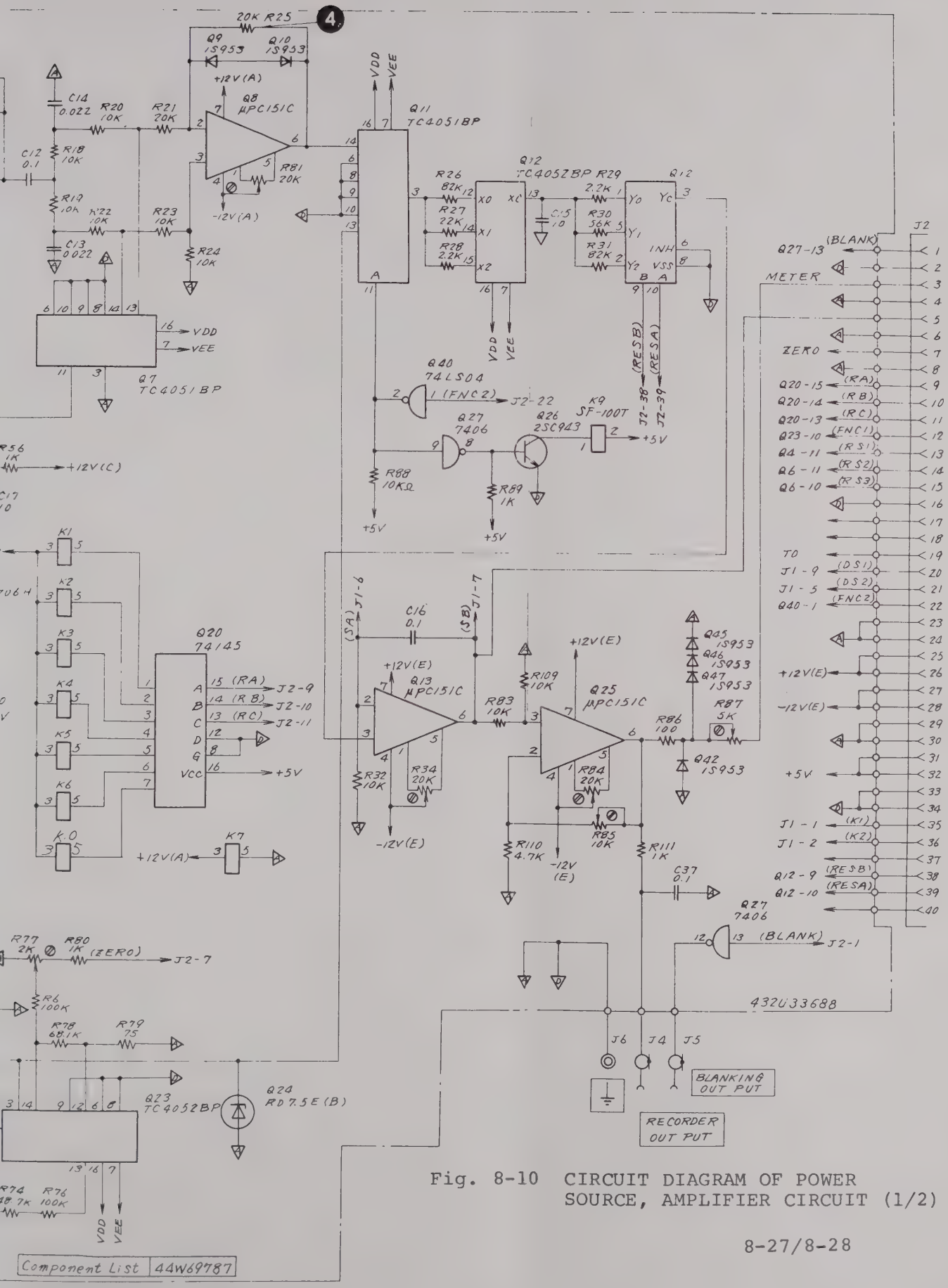
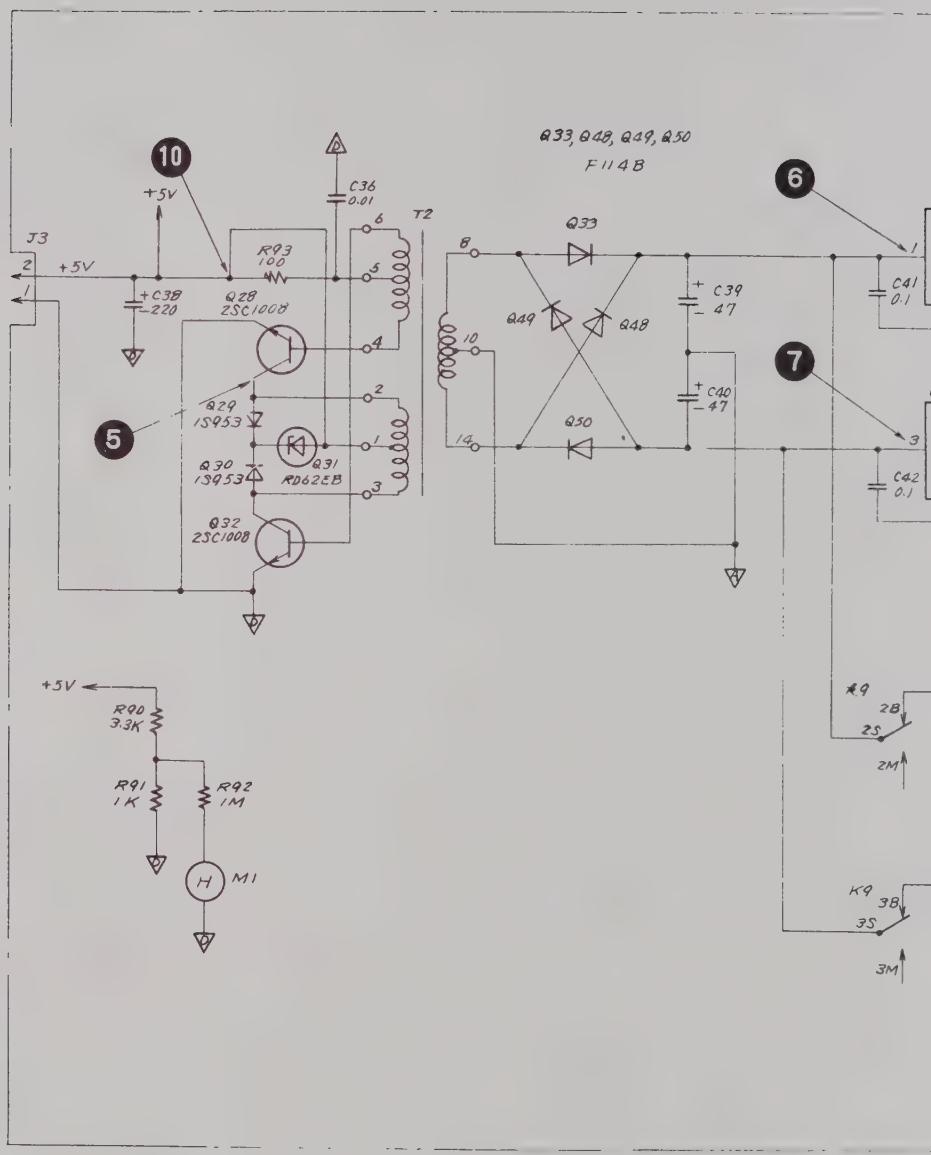


Fig. 8-10 CIRCUIT DIAGRAM OF POWER SOURCE, AMPLIFIER CIRCUIT (1/2)


Q33, Q48, Q49, Q50
F114B
10
+5V
C36
0.01
T2
J3
2
1
+5V
R93
100
+C38
220
QZ8
2SC1008
6
5
4
2
1
3
5
Q29
1S953
Q30
1S953
Q31
RD62EB
Q32
2SC1008
B
10
14
Q33
Q49
Q48
Q50
+C39
47
+C40
47
6
7
1
3
C41
0.1
C42
0.1
K9
2B
2S
2M
K9
3B
3S
3M
+5V
R90
3.3K
R91
1K
R92
1M
H
M1

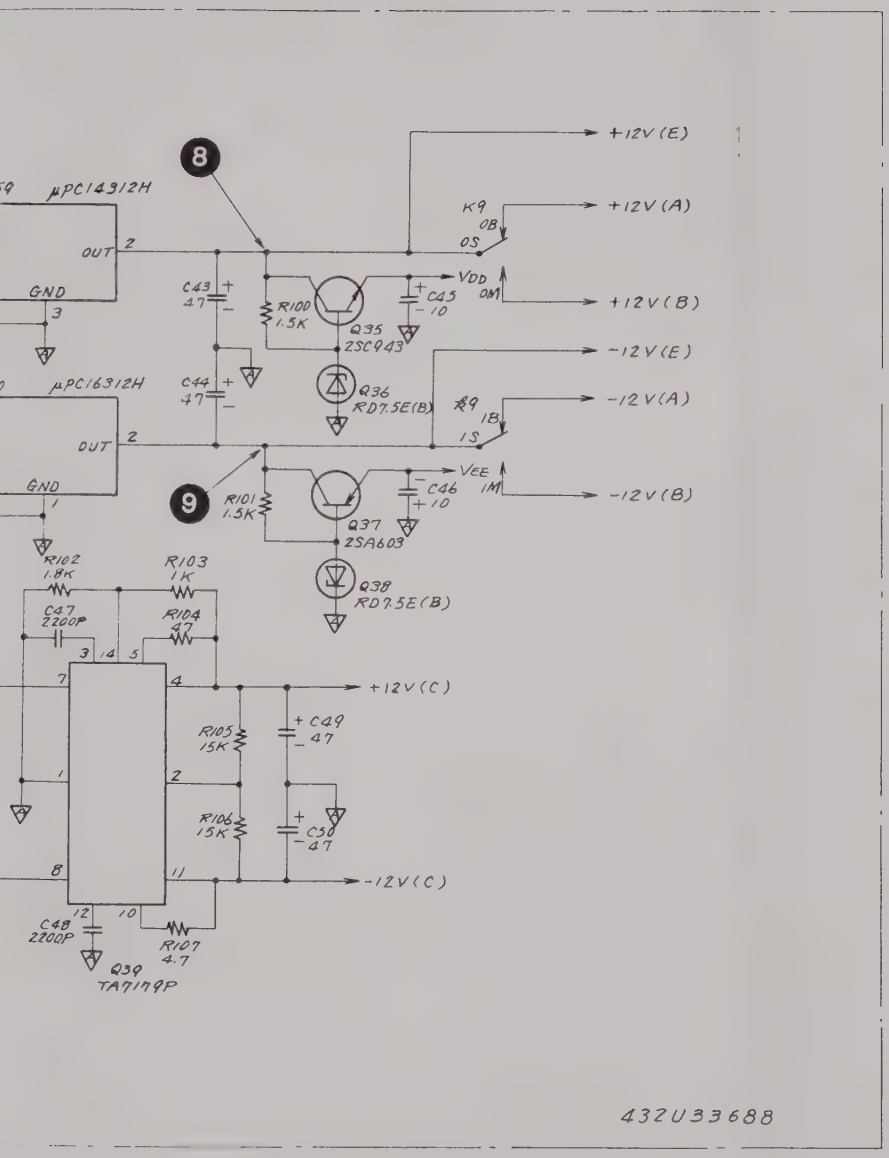


Fig. 8-10 CIRCUIT DIAGRAM OF POWER SOURCE, AMPLIFIER CIRCUIT (2/2)

8.4 +5 V Power Source P.C. Board (442U68387)

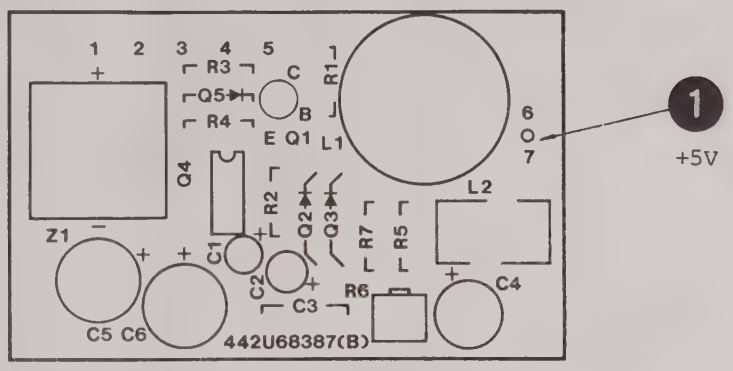
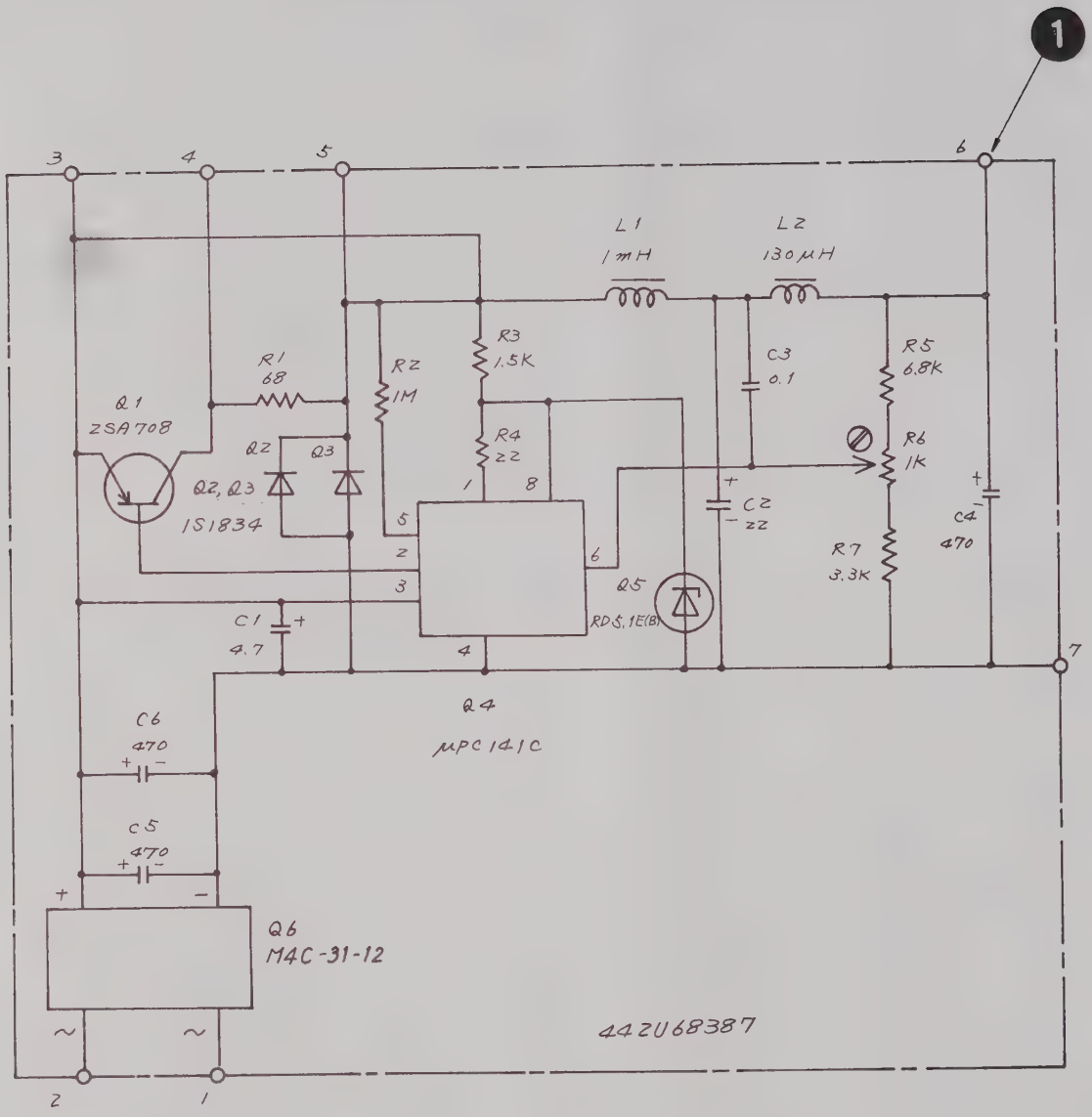
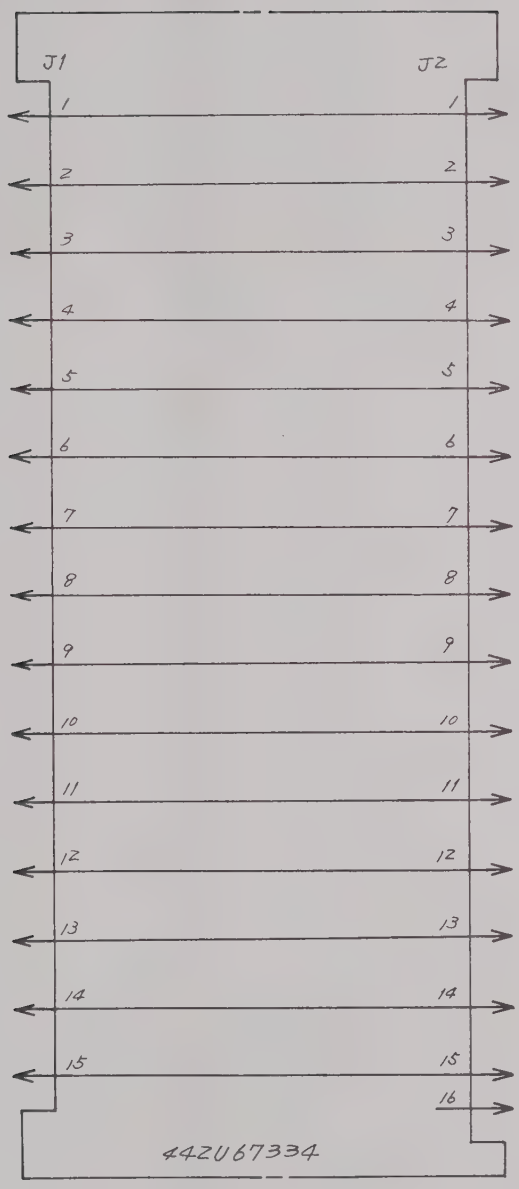


Fig. 8-11 +5 V Power Source P.C. Board
Component Arrangement Diagram



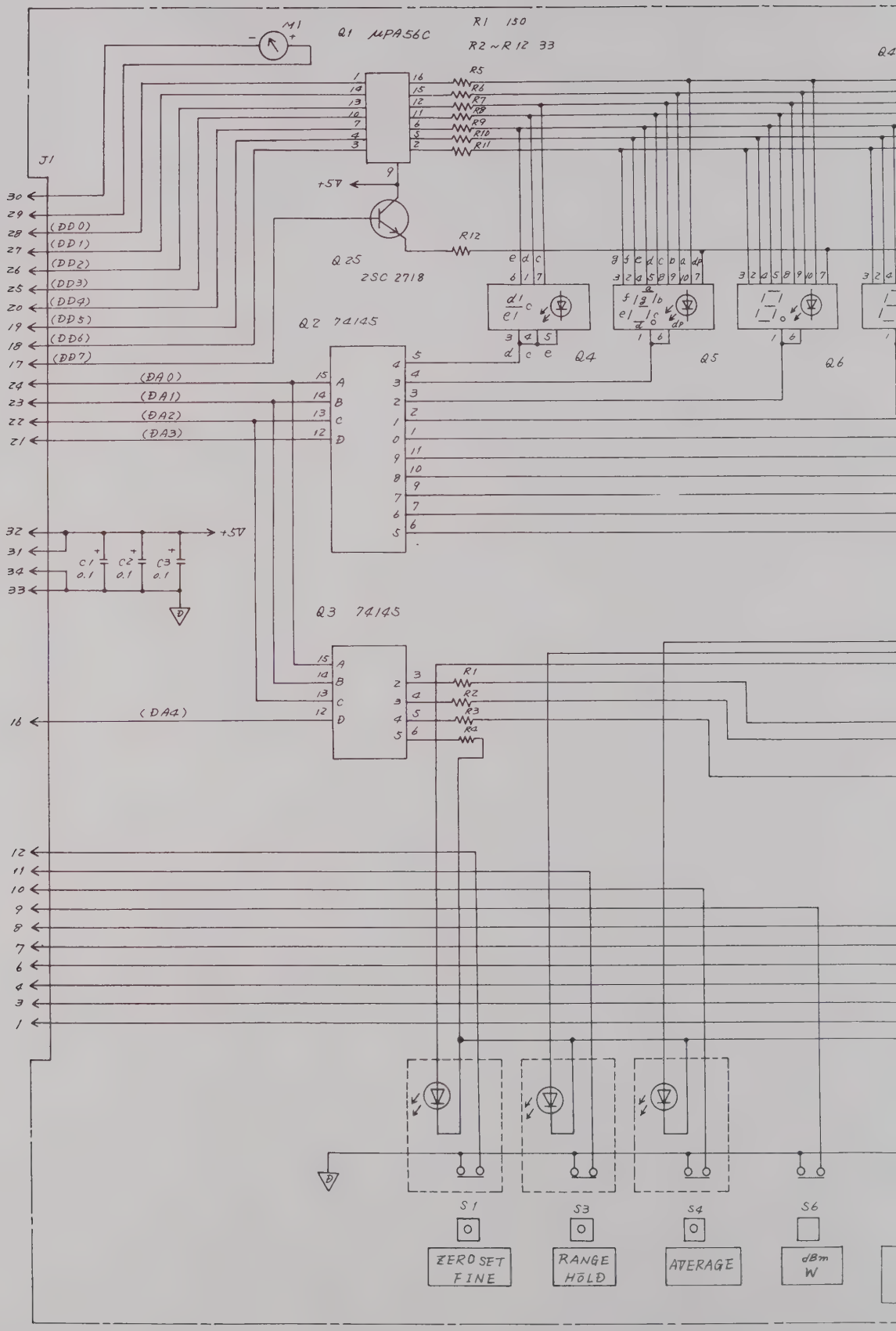
Component list	44W69790

Fig. 8-12 CIRCUIT DIAGRAM OF
5V POWER SOURCE



Component list	44W69785

Fig. 8-13 CIRCUIT DIAGRAM OF CONNECTOR P.C. BOARD


M1
Q1 μPA56C
R1 150
R2 ~ R12 33
J1
+5V
(DD0)
(DD1)
(DD2)
(DD3)
(DD4)
(DD5)
(DD6)
(DD7)
Q25
2SC 2718
R12
Q2 74145
(DA0)
(DA1)
(DA2)
(DA3)
C1 0.1
C2 0.1
C3 0.1
Q3 74145
(DA4)
Q4
Q5
Q6
S1
S3
S4
S6
ZERO SET FINE
RANGE HOLD
AVERAGE
dBm W

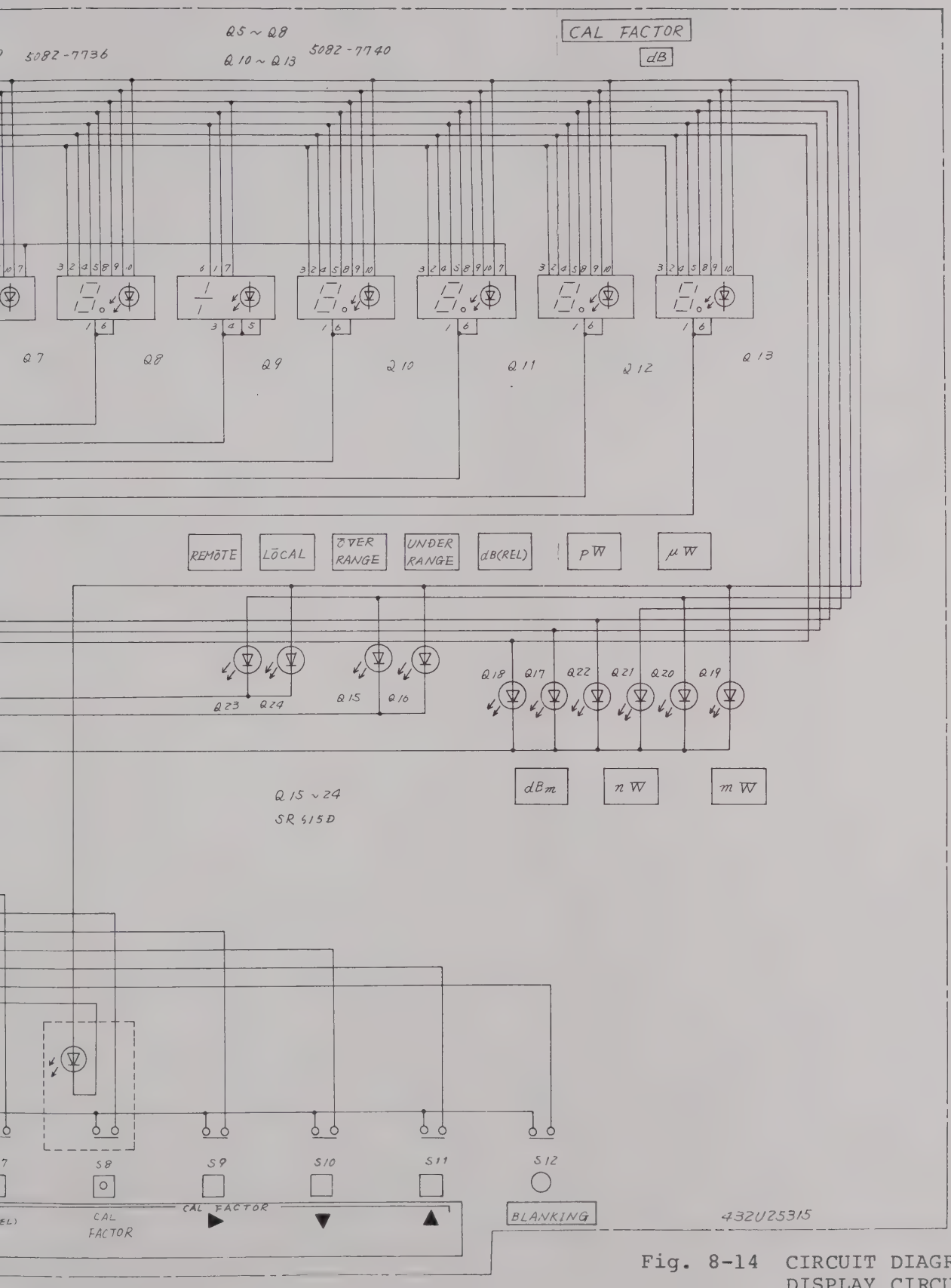
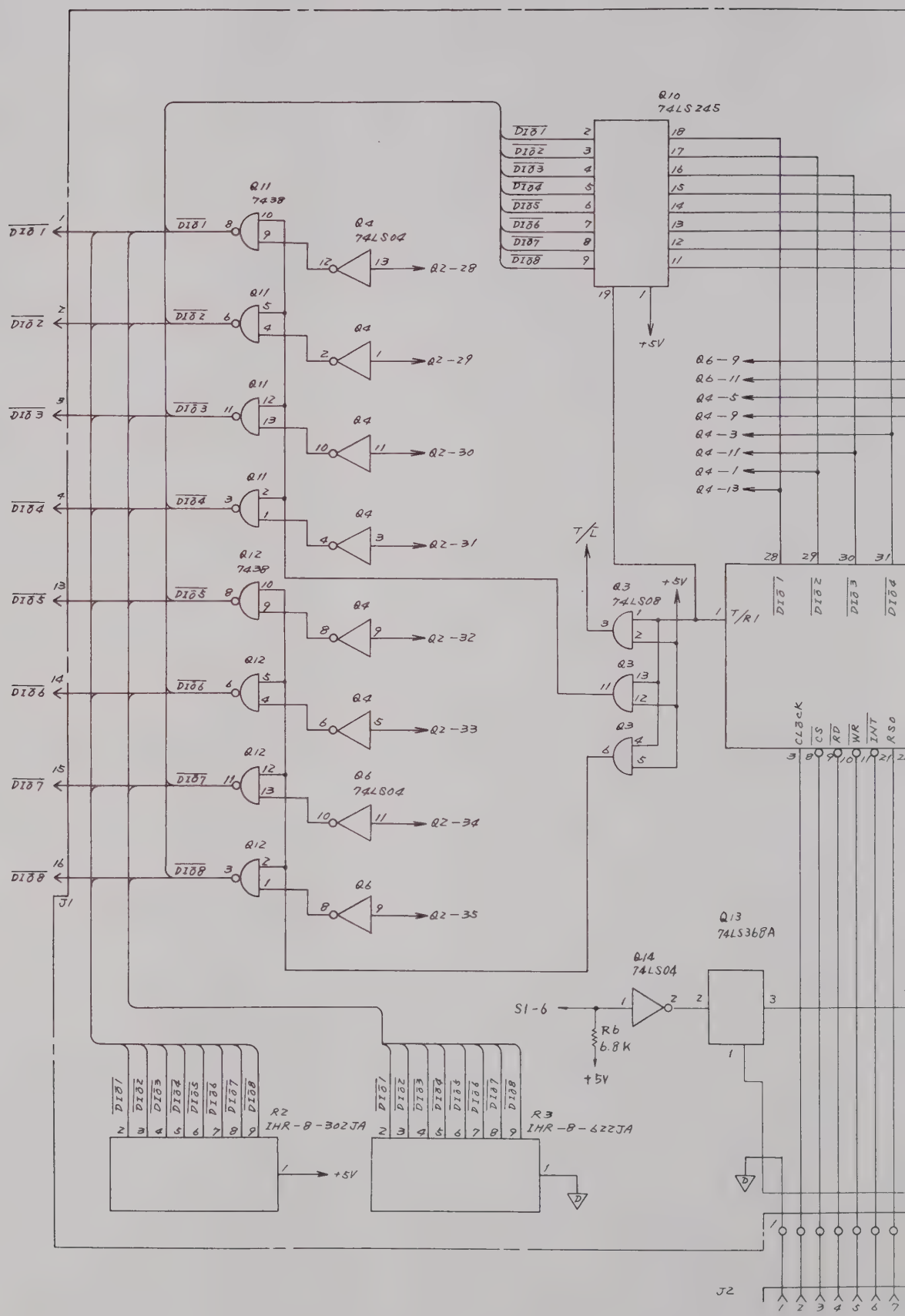
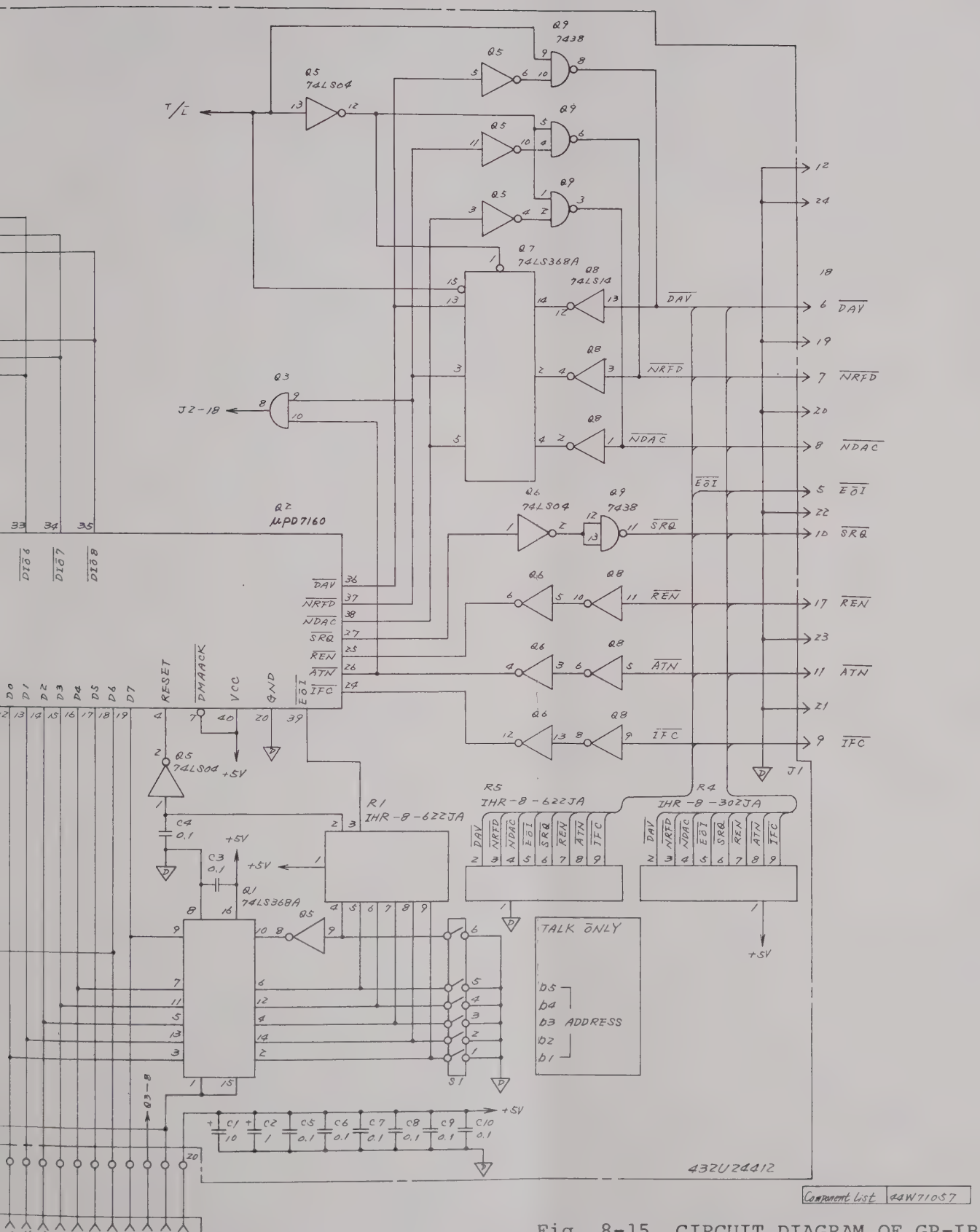


Fig. 8-14 CIRCUIT DIAGRAM OF DISPLAY CIRCUIT

Component List 44W69789


Q10
74LS245
Q11
7438
Q4
74LS04
Q12
7438
Q6
74LS04
Q3
74LS08
Q13
74LS368A
Q14
74LS04
+5V
T/L
T/R1
CLOCK
CS
RD
WR
INT
RS0
S1-6
Rb
6.8K
R2
IHR-8-302JA
R3
IHR-8-622JA
J1
J2
Q2-28
Q2-29
Q2-30
Q2-31
Q2-32
Q2-33
Q2-34
Q2-35
Q6-9
Q6-11
Q4-5
Q4-9
Q4-3
Q4-11
Q4-1
Q4-13



Component list 44W7105?

Fig. 8-15 CIRCUIT DIAGRAM OF GP-IB (OPTION 02)

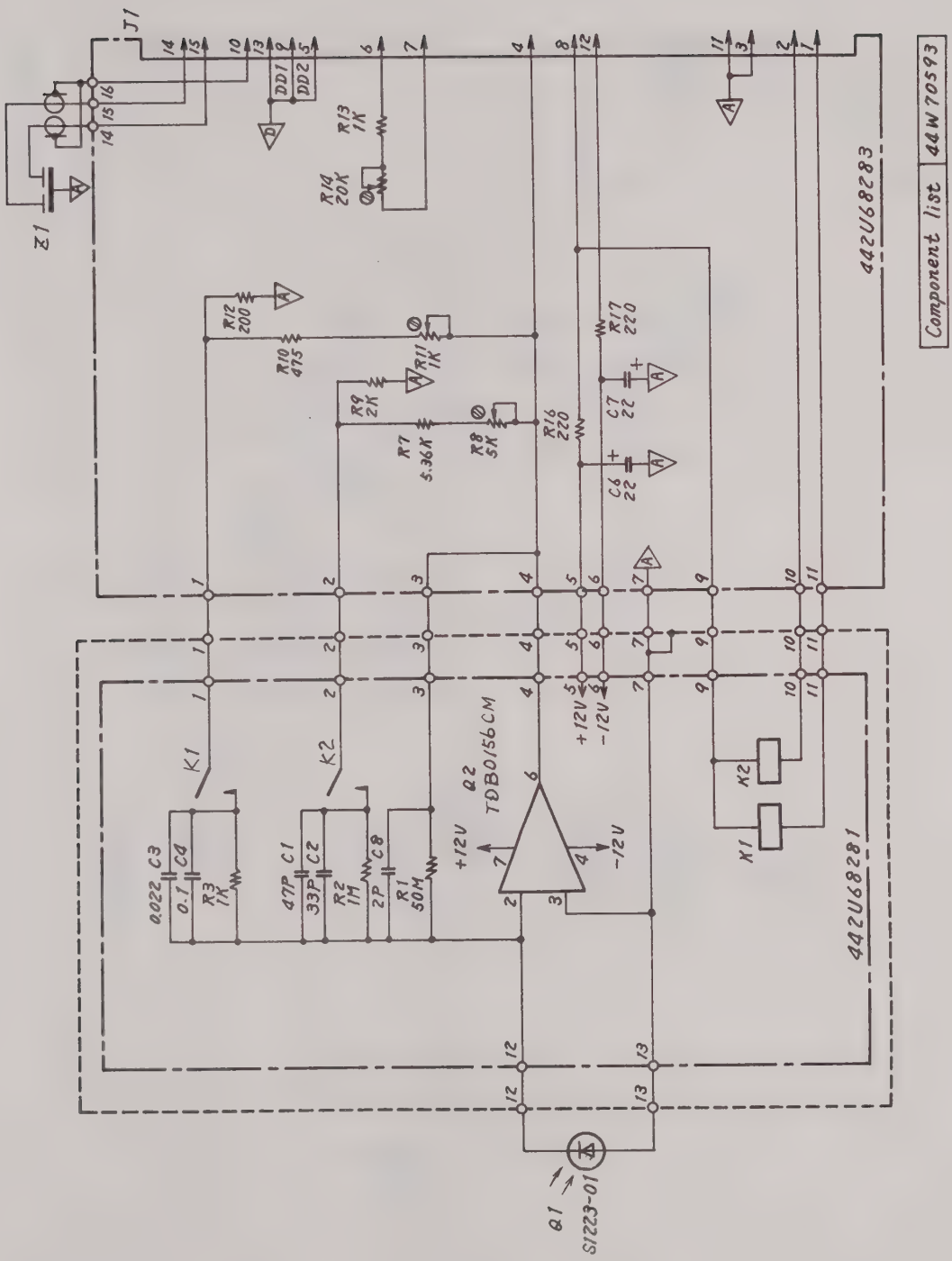


Fig. 8-16 CIRCUIT DIAGRAM OF OPTICAL SENSOR MA95A

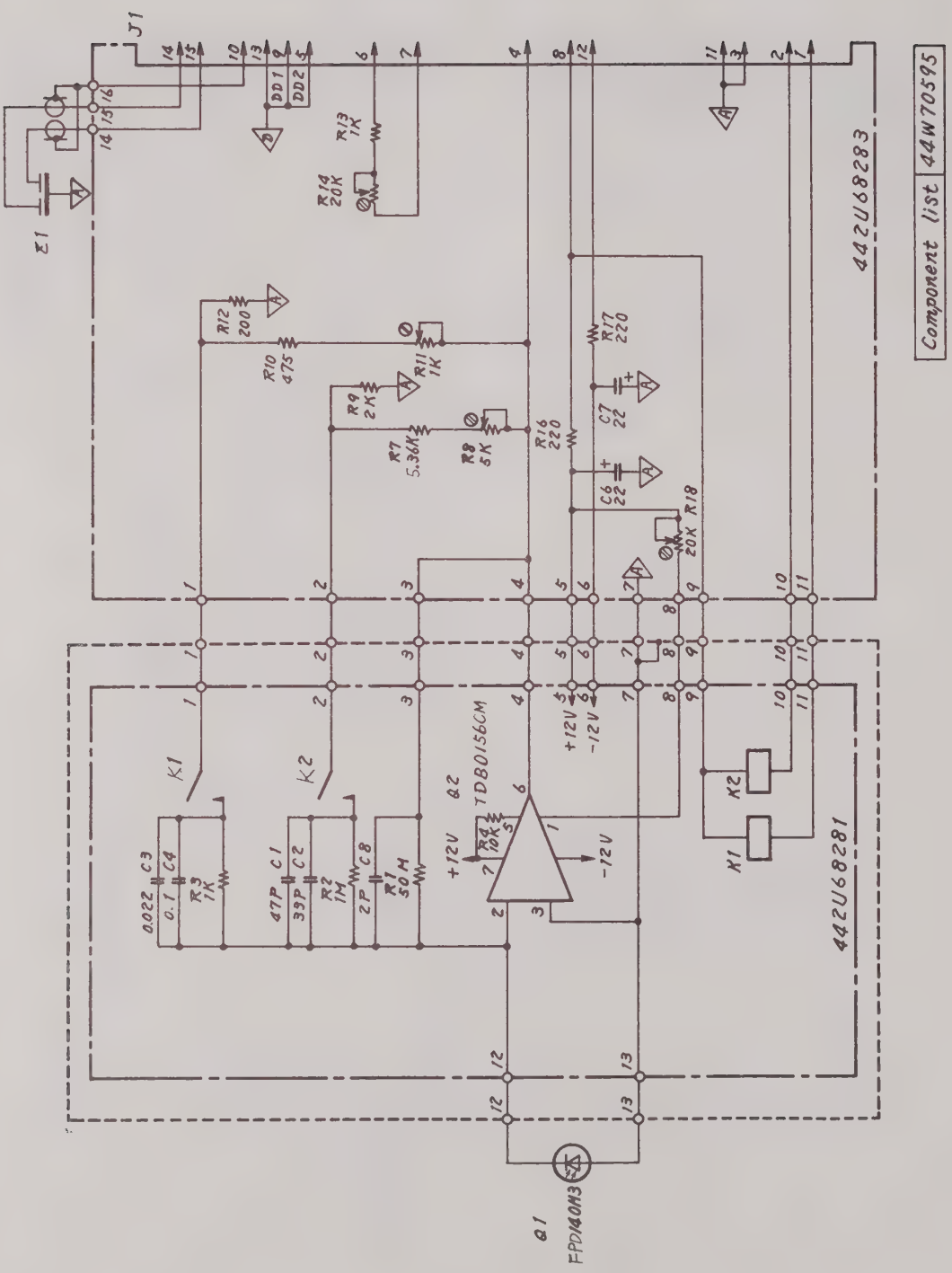


Fig. 8-17 CIRCUIT DIAGRAM OF OPTICAL SENSOR MA96A

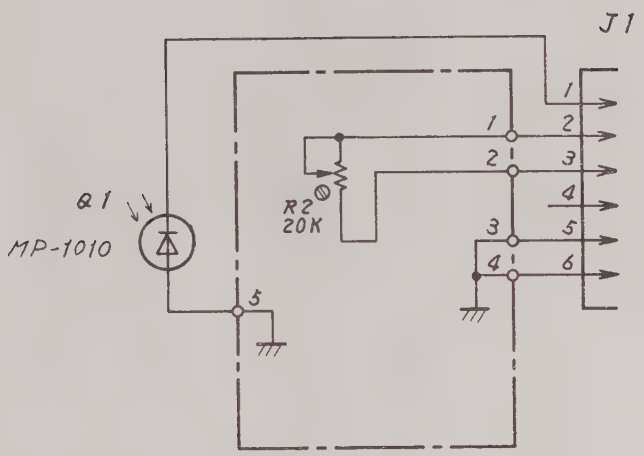


Fig. 8-18 CIRCUIT DIAGRAM OF
OPTICAL SENSOR MA97B

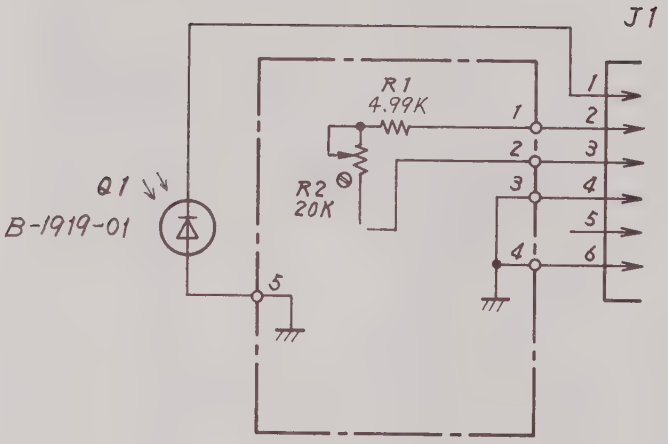


Fig. 8-19 CIRCUIT DIAGRAM OF
OPTICAL SENSOR MA98A

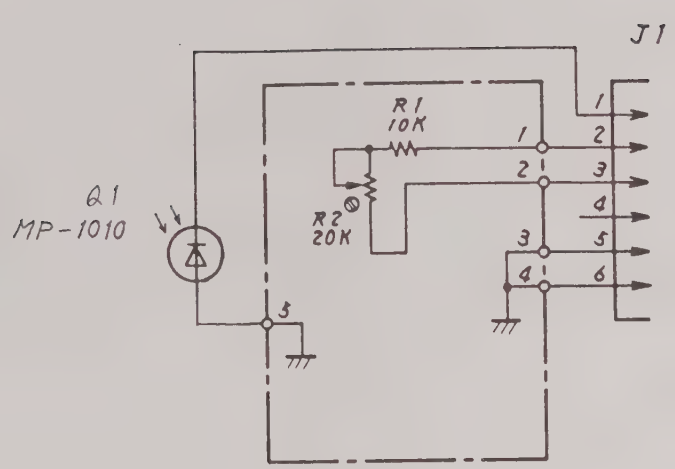


Fig. 8-20 Circuit Diagram of
MA911A/912A Optical Power Sensor

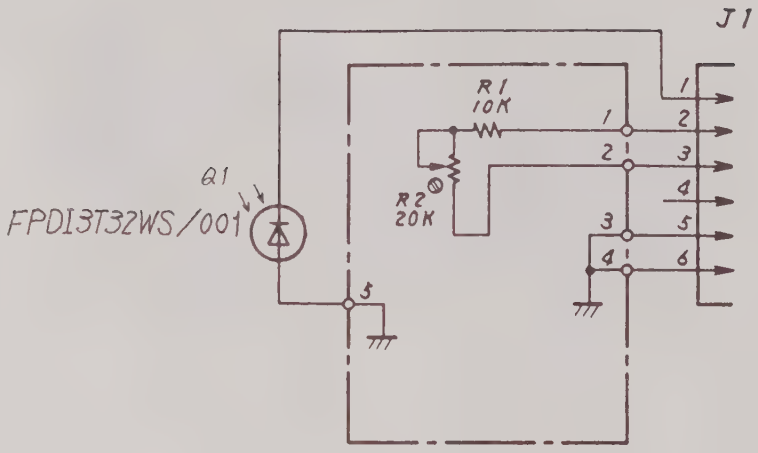


Fig. 8-21 Circuit Diagram of
MA913A Optical Power Sensor

SECTION 9

REPLACEABLE PARTS

9.1 Introduction

This section contains information relative to ordering replacement components. The following table shows circuit reference (hereinafter CKT REF) and abbreviations used for components given in the component list. In the component list, the quantity of each component is one so far as no quantitative description is given in the "NOTE" column.

(1) Circuit reference

AT: Attenuator	K: Relay	Q: Transistor, Diode, Rectifier, IC	T: Transformer
C: Capacitor	L: Coil	R: Resistor	V: Neon lamp, Vaccumtube
F: Fuse	M: Meter, timer	S: Switch	Z: Unit
J: Jack, plug, connector	P: Lamp		

(2) Abbreviations

A	: amperes	J-FET	: junction FET	PNP	: positive-negative-positive
Att. R var	: attenuator variable using film resistive elements	k	: kilo ($\times 10^3$)	p-p, pp	: peak to peak value
BL	: boundary layer	LED	: light emitting diode	RFC	: RF choke
				R-lamp	: resistor lamp
Cer	: ceramic	M	: mega ($\times 10^6$)	rms	: effective value (root means square)
CF	: carbon film	m	: milli ($\times 10^{-3}$)		
Comp	: composition	MF	: metallized film	SBD	: shottky barrier diode
CRT	: cathode-ray tube	MOS-FET	: metal oxide semi-conductor FET	SCR	: sillicon controlled rectifier
		M paper	: metallized paper	Si	: sillicon
Di	: diode	M plast	: metallized plastic film	SRD	: step recovery diode
DIL type	: dual-in line type	Multi	: multiplying		
				Tant	: tantalum
Elect	: electrolyte aluminum	N ch	: N channel	Tr	: transistor
		non-lin	: non-linear taper	Trans	: transformer
F	: farad	Non-pol	: non-polarity		
FET	: field effect transistor	NPN	: negative-positive-negative	μ	: micro ($\times 10^{-6}$)
G	: ground			V	: volt
Ge	: germanium	Ω	: ohms	Var	: variable
H	: henry				
Hz	: hertz	p	: pico ($\times 10^{-12}$)	WW	: wire wound
		Plast	: plastic film		
IC	: integrated circuit	PMTR	: potentiometer	XTAL	: crystal
IEC	: Applicable to IEC Safety Standard				

9.2 Reading Capacitors Resistors

9.2.1 Capacitor Identification

Value in Picofarads (pF)

Number of zero's following the value

EXAMPLES: 103 = 10,000pF = 10^{-8}F or 0.01μF

302 = 3,000pF = $3x10^{-9}$F or 0.003μF

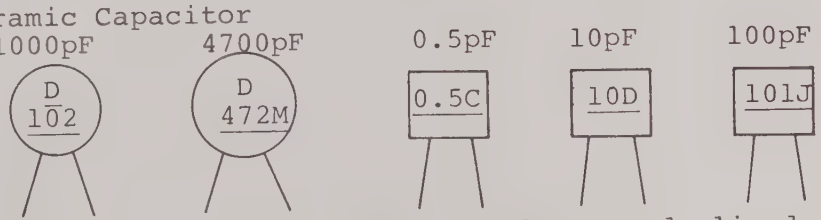
676 = 67,000,000pF = $67x10^{-6}$F or 67μF

(a) Ceramic capacitor, polyester capacitor

Indication	0.5	1	10	101	102	103	104
Capacity	0.5pF	1pF	10pF	100pF	1000pF	0.01μF	0.1μF

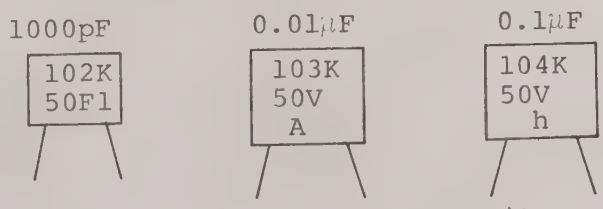
Example:

Ceramic Capacitor



Capacity values are always underlined.

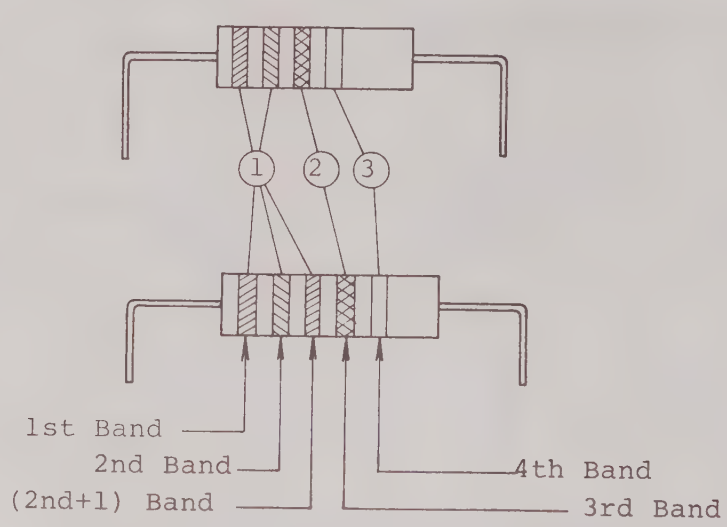
Polyester Capacitor



(b) Tantalum capacitor. Metallized capacitor and Electrolytic capacitor

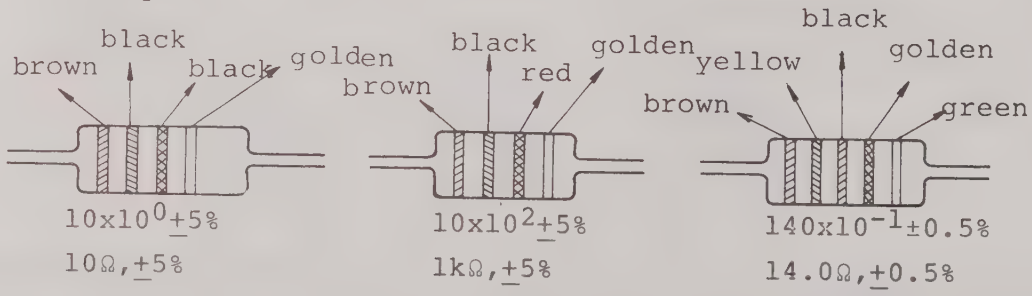
Indication	OR47	010	100	101
Capacity	0.47μF	1μF	10μF	100μF

9.2.2 Resistor Identification



COLOR	① Figure		② Multiplier	③ Tolerance
	1st	2nd	3rd	4th
Black	0	0	$x10^0$	-
Brown	1	1	$x10^1$	-
Red	2	2	$x10^2$	-
Orange	3	3	$x10^3$	-
Yellow	4	4	$x10^4$	-
Green	5	5	$x10^5$	±0.5%
Blue	6	6	$x10^6$	-
Purple	7	7	$x10^7$	-
Grey	8	8	$x10^8$	-
White	9	9	$x10^9$	-
Gold	-	-	$x10^{-1}$	±5%
Silver	-	-	$x10^{-2}$	±10%
-----	-	-		±20%

For Example:



9.3 Ordering Information

Upon ordering components, please give the following descriptions by referring to the C.L. (Component List).

Item	Example
(1) Name of instrument	Optical Power Meter ML93B
(2) Name of component List	Component List of Control Circuit
(3) CKT REF	C16
(4) Name of component	CK45D1H 102MY Note: Part name is given in parentheses ( ) in the C.L. (Component List). Components with asterisks* are those that require factory adjustment upon repairing. When ordering a component or components with asterisk, give full description of the component.
(5) Quantity	1
(6) Serial No. of instrument	Serial No. M31257

9.4 Component List

COMPONENT LIST OF OPTICAL POWER METER ML93B

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Elect,(CE62W1V472)	4700μF,+100/-10%,35V		
F 1	Fuse, (MF51NN250V * AAC05)	* A		
F 2	Fuse, (MF51NN250V2AAC05)	2A		
J 1	Housing, connector, (PI011-2F)			
J 2	Receptacle,(P-1306-DB)			
J 3	Power supply cord with plug			
Q 1	Tr,Si,NPN,(2SD297)			
S 1	Lever,(8M4021)			
T 1	Trans,(44T65701)	26VA		
Z 1	442U67334P.C.Board CONNECTOR BOARD			44W69785
Z 2	432U25319P.C.Board POWER SOURCE, AMPLIFIER SECTION			44W69787
Z 3	432U25317P.C.Board CONTROL CIRCUIT			44W69788
Z 4	432U25315P.C.Board DISPLAY CIRCUIT			44W69789
Z 5	432U24412P.C.Board IEC-IB			OPTION
Z 6	Noise filter, (ZGB2202-01)			
Z 7	442U68387P.C.Board 5V POWER SOURCE			44W69790

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF CONNECTOR BOARD

CKT REF	DESCRIPTION	RATING		NOTE
J 1	Connector,(U-PA1521)			
J 2	Connector, (R15A-17R-16PB)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF POWER SOURCE, AMPLIFIER SECTION

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Tant,(CS02H1V100M)	10μF,±20%,35V		
C 2	Tant,(CS02H1V100M)	10μF,±20%,35V		
C 3	Plast,(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 4	Tant,(CS02H1D2R2M)	2.2μF,±20%,20V		
C 5	Not assigned			
C 6	Elect,(CE04W1V220)	22μF,+100/-10%,35V		
C 7	Elect,(CE04W1V220)	22μF,+100/-10%,35V		
C 8	Cer,(RD312CH151JY50)	150pF,±5%,50V		
C 9	Tant,(CS02H0J6R8M)	6.8μF,±20%,6.3V		
C 10	Tant,(CS02H0J6R8M)	6.8μF,±20%,6.3V		
C 11	Cer,(RD314CH471JY50)	470pF,±5%,50V		
C 12	Plast,(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 13	Plast,(ECQ-M1H223KZ)	0.022μF,±10%,50V		
C 14	Plast,(ECQ-M1H223KZ)	0.022μF,±10%,50V		
C 15	Tant,(432A1003 106K)	10μF,±10%,100V		
C 16	Plast,(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 17	Elect,(CE04W1V100)	10μF,+100/-10%,35V		
C 18	Plast,(ECQ-M1H 223KZ)	0.022μF,±10%,50V		
C 19	Elect,(CE04W1A221)	220μF,+100/-10%,10V		
C 20	Plast,(ECQ-M1H 103KZ)	0.01μF,±10%,50V		
C 21	Tant,(CS02H1V010M)	1μF,±20%,35V		
C 22	Tant,(CS02H1V010M)	1μF,±20%,35V		
C 23	Plast,(ECQ-M1H 472KZ)	4700pF,±100%,50V		
C 24	Plast,(ECQ-M1H 223KZ)	0.022μF,±10%,50V		
C 25	Plast,(ECQ-M1H 223KZ)	0.022μF,±10%,50V		
C 26	Not assigned			
C 27	Elect,(CE04W1E101)	100μF,+100/-10%,25V		
C 28	Elect,(CE04W1V220)	22μF,+100/-10%,35V		
C 29	Cer,(CK924C1H103M)	0.01μF,±20%,50V		
C 30	Plast,(ECQ-M1H 102KZ)	1000pF,±10%,50V		
C 31	Not assigned			
C 32	Not assigned			
C 33	Cer,(CK924C1H104M)	0.1μF,±20%,50V		
C 34	Cer,(CK924C1H104M)	0.1μF,±20%,50V		
C 35	Cer,(CK924C1H104M)	0.1μF,±20%,50V		
C 36	Plast,(ECQ-M1H 103KZ)	0.01μF,±10%,50V		
C 37	Plast,(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 38	Elect,(CE04W1A221)	220μF,+100/-10%,10V		
C 39	Elect,(CE04W1E470)	47μF,+100/-10%,25V		
C 40	Elect,(CE04W1E470)	47μF,+100/-10%,25V		
C 41	Cer,(CK924C1H104M)	0.1μF,±20%,50V		
C 42	Cer,(CK924C1H104M)	0.1μF,±20%,50V		
C 43	Elect,(CE04W1E470)	47μF,+100/-10%,25V		
C 44	Elect,(CE041E470)	47μF,+100/-10%,25V		
C 45	Elect,(CE04W1V100)	10μF,+100/-10%,35V		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF POWER SOURCE, AMPLIFIER SECTION

CKT REF	DESCRIPTION	RATING	NOTE
C 46	Elect,(CE04W1V100)	10μF,+100/-10%,35V	
C 47	Cer,(CK45D1H222MY)	2200pF,±20%,50V	
C 48	Cer,(CK45D1H222MY)	2200pF,±20%,50V	
C 49	Elect,(CE04W1E470)	47μF,+100/-10%,25V	
C 50	Elect,(CE04W1E470)	47μF,+100/-10%,25V	
C 51	Not assigned		
C 52	Cer,(CC924C1H471J)	470pF,±5%,50V	
C 53	Cer,(CC924C1H102J)	0.01μF,±5%,50V	
C 54	Cer,(CK924C1H103M)	0.01μF,±20%,50V	
C 55	Cer,(CK924C1H103M)	0.01μF,±20%,50V	
C 56	Cer,(CK924C1H103M)	0.01μF,±20%,50V	
J 1	Connector,(U-SA1501)		
J 2	Connector, (HIF23A-40D-AA,10S)		
J 3	Connector,(PI011-2M)		
J 4	Receptacle,(BNC-R101)		
J 5	Receptacle,(BNC-R101)		
J 6	Terminal with knob	10ø	
K 1	Reed relay,(NR-SD-12V)		
K 2	Reed relay,(NR-SD-12V)		
K 3	Reed relay,(NR-SD-12V)		
K 4	Reed relay,(NR-SD-12V)		
K 5	Reed relay,(NR-SD-12V)		
K 6	Reed relay,(NR-SD-12V)		
K 7	Reed relay,(NR-SD-12V)		
K 8	Not assigned		
K 9	Relay,(SF-100F)		
K 10	Reed relay,(NR-SD-12V)		
M 1	Timer,(TM-O)		
Q 1	IC,(μPC151C)		
Q 2	Di,breakdown,(RD7.5EB)	7.0 to 7.9V,400mW	
Q 3	Di,breakdown,(RD7.5EB)	7.0 to 7.9V,400mW	
Q 4	IC,(TC4051BP)		
Q 5	IC,(μPC251A)		
Q 6	IC,(TC4051BP)		
Q 7	IC,(TC4051BP)		
Q 8	IC,(μPC151C)		
Q 9	Di,Si,(1S953)		
Q 10	Di,Si,(1S953)		
Q 11	IC,(TC4051BP)		
Q 12	IC,(TC4052BP)		
Q 13	IC,(μPC151C)		
Q 14	IC,(μPC151C)		
Q 15	IC,(μPC251A)		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF POWER SOURCE, AMPLIFIER SECTION

CKT REF	DESCRIPTION	RATING		NOTE
Q 16	IC,(μPC251A)			
Q 17	Di,breakdown,(RD6.2EB)	5.8 to 6.6V,400MW		
Q 18	Di,breakdown,(RD7.5EB)	7.0 to 7.9V,400mW		
Q 19	Tr,Si,NPN,(2SC1706Ⓗ)			
Q 20	IC,(74145)			
Q 21	IC,(ICL7650)			
Q 22	Not assigned			
Q 23	IC,(RC4052BP)			
Q 24	Di,breakdown,(RD7-5EB)	7.0 to 7.9V,400mW		
Q 25	IC,(μPC151C)			
Q 26	Tr,Si,NPN,(2SC943)			
Q 27	IC,(7406)			
Q 28	Tr,Si,NPN,(2SC1008)			
Q 29	Di,Si,(1S953)			
Q 30	Di,Si,(1S953)			
Q 31	Di,breakdown,(RD6.2EB)	5.8 to 6.6V,400mW		
Q 32	Tr,Si,NPN,(2SC1008)			
Q 33	Di,(F114B)			
Q 34	Not assigned			
Q 35	Tr,Si,NPN,(2SC943)			
Q 36	Di,brrakdown,(RD7.5EB)	7.0 to 7.9V,400mW		
Q 37	Tr,Si,PNP,(2SA603)			
Q 38	Di,breakdown,(RD7-5EB)	7.0 to 7.9V,400mW		
Q 39	IC,(TA7179P)			
Q 40	IC,(74LS04)			
Q 41	Not assigned			
Q 42 to Q 47	Di,Si,(1S953)			
Q 48	Di,(F114B)			
Q 49	Di,(F114B)			
Q 50	Di,(F114B)			
Q 51	Tr,Si,NPN,(2SC1008)			
Q 52	Tr,Si,PNP,(2SA708)			
Q 53	Tr,Si,NPN,(2SC943)			
Q 54	Tr,Si,PNP,(2SA603)			
Q 55	Di,breakdown,(RD6.2EB)	5.8 to 6.6V,400mW		
Q 56	Di,breakdown,(RD6.2EB)	5.8 to 6.6V,400mW		
Q 57	Di,Si,(1S953)			
Q 58	Di,Si,(1S953)			
Q 59	3 terminal regulator, (μPC14312H)			
Q 60	3 terminal regulator, (μPC16312H)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF POWER SOURCE, AMPLIFIER SECTION

CKT REF	DESCRIPTION	RATING		NOTE
R 1	MF,(RN05C2B1001D)	1kΩ,±0.5%,1/8W		
R 2	CF,(ARD25T223J)	22kΩ,±5%,1/4W		
R 3	CF,(ARD25T473J)	47kΩ,±5%,1/4W		
R 4	MF,(RN05C2B1001D)	1kΩ,±0.5%,1/8W		
R 5	MF,(RN05C2B1001D)	1kΩ,±0.5%,1/8W		
R 6	MF,(RN14K2E1003D)	100kΩ,±0.5%,1/4W		
R 7	MF,(RN052B1102D)	11kΩ,±0.5%,1/8W		
R 8	MF,(RN052B1110D)	111Ω,±0.5%,1/8W		
R 9	MF,(RN052B1001D)	1kΩ,±0.5%,1/8W		
R 10	MF,(RN052E1003D)	100kΩ,±0.5%,1/4W		
R 11	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 12	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 13	MF,(RN05C2B1002D)	10kΩ,±0.5%,1/8W		
R 14	MF,(RN05C2B1001D)	1kΩ,±0.5%,1/8W		
R 15	MF,(RN05C2B1110D)	111Ω,±0.5%,1/8W		
R 16	MF,(RN05C2B1001D)	1kΩ,±0.5%,1/8W		
R 17	MF,(RN05C2E1003D)	100kΩ,±0.5%,1/4W		
R 18	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 19	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 20	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 21	MF,(RN14K2E2002D)	20kΩ,±0.5%,1/4W		
R 22	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 23	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 24	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 25	MF,(RN05C2B2002D)	20kΩ,±0.5%,1/8W		
R 26	CF,(ARD25T823J)	82kΩ,±5%,1/4W		
R 27	CF,(ARD25T223J)	22kΩ,±5%,1/4W		
R 28	CF,(ARD25T222J)	2.2kΩ,±5%,1/4W		
R 29	CF,(ARD25T222J)	2.2kΩ,±5%,1/4W		
R 30	CF,(ARD25T223J)	22kΩ,±5%,1/4W		
R 31	CF,(ARD25T823J)	82kΩ,±5%,1/4W		
R 32	MF,(RN05C2B1002D)	10kΩ,±0.5%,1/8W		
R 33	Not assigned			
R 34	Var,MF,(RJ-6P 20kΩ)	Max.20kΩ		
R 35	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 36	CF,(ARD25T224J)	220kΩ,±5%,1/4W		
R 37	CF,(ARD25T334J)	330kΩ,±5%,1/4W		
R 38	CF,(ARD25T104J)	100kΩ,±5%,1/4W		
R 39	Var,MF,(RJ-6P 20kΩ)	Max.20kΩ		
R 40	CF,(ARD25T392J)	3.9kΩ,±5%,1/4W		
R 41	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 42	CF,(ARD25T183J)	18kΩ,±5%,1/4W		
R 43	Var,MF,(RJ-6P 5KΩ)	Max.5kΩ		
R 44	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 45	CF,(ARD25T104J)	100kΩ,±5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF POWER SOURCE, AMPLIFIER SECTION

CKT REF	DESCRIPTION	RATING		NOTE
R 46	CF,(ARD25T104J)	100kΩ,±5%,1/4W		
R 47	CF,(ARD25T104J)	100kΩ,±5%,1/4W		
R 48	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 49	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 50	Var,MF,(RJ-6P 20kΩ)	Max.20kΩ		
R 51	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 52	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 53	CF,(ARD25T223J)	22kΩ,±5%,1/4W		
R 54	CF,(ARD25T473J)	47kΩ,±5%,1/4W		
R 55	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 56	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 57	CF,(ARD25T101J)	100Ω,±5%,1/4W		
R 58	MF,(RN14K2E1000D)	100Ω,±0.5%,1/4W		
R 59	MF,(RN14K2E1001D)	1kΩ,±0.5%,1/4W		
R 60	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 61	MF,(RN14K2E1003D)	100kΩ,±0.5%,1/4W		
R 62	MF,(GS1/4B1MΩF)	1MΩ,±1%,1/4W		
R 63	MF,(GS1/4B10MΩF)	10MΩ,±1%,1/4W		
R 64	MF,(RN05C2B9902D)	99kΩ,±0.5%,1/8W		
R 65	MF,(RN14K2E1001D)	1kΩ,±0.5%,1/4W		
R 66	MF,(RN14K2E1001D)	1kΩ,±0.5%,1/4W		
R 67	Not assigned			
R 68	MF,(GS1/4B1MΩF)	1MΩ,±1%,1/4W		
R 69	MF,(RN14K2E1003D)	100kΩ,±0.5%,1/4W		
R 70	CF,(ARD25T101J)	100Ω,±5%,1/4W		
R 71	CF,(ARD25T105J)	1MΩ,±5%,1/4W		
R 72	Var,MF, (RG161P20SB10kΩM)	Max.10kΩ		
R 73	Not assigned			
R 74	MF,(RN14K2E4872D)	48.7kΩ,±0.5%,1/4W		
R 75	MF,(RN05C2E9901D)	9.9kΩ,±0.5%,1/4W		
R 76	MF,(RN14K2E1003D)	100kΩ,±0.5%,1/4W		
R 77	Var,MF,(RJ-6P 2KΩ)	Max.2kΩ		
R 78	MF,(RN14k2E6812D)	68.1kΩ,±0.5%,1/4W		
R 79	MF,(RN14K2E75R0D)	75Ω,±0.5%,1/4W		
R 80	MF,(RN14K2E.001D)	1kΩ,±0.5%,1/4W		
R 81	Var,MF,(RJ-6P 20KΩ)	Max.20kΩ		
R 82	CF,(ARD25T101J)	100Ω,±5%,1/4W		
R 83	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 84	Var,MF,(RJ-6P 20KΩ)	Max.20kΩ		
R 85	Var,MF,(RJ-6P 10kΩ)	Max.10kΩ		
R 86	CF,(ARD25T101J)	100Ω,±5%,1/4W		
R 87	Var,MF,(RJ-6P 5KΩ)	Max.5kΩ		
R 88	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 89	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 90	CF,(ARD25T332J)	3.3kΩ,±5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF POWER SOURCE, AMPLIFIER SECTION

CKT REF	DESCRIPTION	RATING		NOTE
R 91	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 92	CF,(ARD25T105J)	1MΩ,±5%,1/4W		
R 93	CF,(ARD25T101J)	100Ω,±5%,1/4W		
R 94 to R 99	Not assigned			
R100	CF,(ARD25T152J)	1.5kΩ,±5%,1/4W		
R101	CF,(ARD25T152J)	1.5kΩ,±5%,1/4W		
R102	CF,(ARD25T182J)	1.8kΩ,±5%,1/4W		
R103	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R104	CF,(ARD25T4R7J)	4.7Ω,±5%,1/4W		
R105	CF,(ARD25T153J)	15kΩ,±5%,1/4W		
R106	CF,(ARD25T153J)	15kΩ,±5%,1/4W		
R107	CF,(ARD25T4R7J)	4.7Ω,±5%,1/4W		
R108	Var,MF,(RJ-6P 10kΩ)	Max.10kΩ		
R109	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R110	CF,(ARD25T472J)	4.7kΩ,±5%,1/4W		
R111	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R112	CF,(ARD25T182J)	1.8kΩ,±5%,1/4W		
R113	CF,(ARD25T182J)	1.8kΩ,±5%,1/4W		
R114	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R115	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
T 1	Trans,(ST-26)			
T 2	Trans,(439T14952)	26VA		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF CONTROL CIRCUIT

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Plast,(ECQ-M1H104KZ)	0.1μF,±10%,50V		
C 2	Plast,(ECQ-M1H104KZ)	0.1μF,±10%,50V		
C 3	Tant,(CS02H1V010M)	1μF,±20%,35V		
C 4	Cer,(CK45D1H103MY)	0.01μF,±20%,50V		
C 5	Plast,(ECQ-M1H * KZ)	0.047 to 0.1μF,±10%, 50V		*
C 6	Plast,(ECQ-M1H * KZ)	0.047 to 0.1μF,±10%, 50V		*
C 7	Cer,(CC92CH1H * DY)	4 to 100pF,±0.5pF, 50V		*
C 8	Cer,(CK45D1H103MY)	0.01μF,±20%,50V		
C 9	Cer,(CK45D1H103MY)	0.01μF,±20%,50V		
C10	Not assigned			
C11	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C12	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C13	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C14	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C15	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C16	Cer,(CK45D1H102MY)	1000pF,±20%,50V		
C17	Cer,(CK45D1H102MY)	1000pF,±20%,50V		
C18	Tant,(CS02H1D150M)	15μF,±20%,20V		
C19	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C20	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C21	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C22	Not assigned			
C23	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C24	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C25	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C26	Tant,(CS02H1D2R2M)	2.2μF,±20%,20V		
C27	Tant,(CS02H1D2R2M)	2.2μF,±20%,20V		
C28	Tant,(CS02H1D2R2M)	2.2μF,±20%,20V		
C29	Tant,(CS02H1D2R2M)	2.2μF,±20%,20V		
C30	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C31	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
J 1	Connector, (HIF3-40P-2.54DSA)	40 pins		
J 2	Connector, (HIF23A-34-D-AA10S)	34 pins		
J 3	Not assigned			
J 4	Connector, (HIF3-20P-2.54DSA)	20 pins		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF CONTROL CIRCUIT²

CKT REF	DESCRIPTION	RATING		NOTE
Q 1	Di,breakdown, (RD5.1E(B))	4.8 to 5.4V,400mW		
Q 2	Di,breakdown, (RD5.1E(B))	4.8 to 5.4V,400mW		
Q 3	Not assigned			
Q 4	IC,(ICL7109CPL)			
Q 5	IC,(74LS175)			
Q 6	IC,(TC4508BP)			
Q 7	IC,(TC5012BP)			
Q 8	IC,(TC5012BP)			
Q 9	IC,(TC5012BP)			
Q10	IC,(TC4042BP)			
Q11	IC,(TC4042BP)			
Q12	IC,(TC4042BP)			
Q13	IC,(μPC610D)			
Q14	IC,(μPD780C)			
Q15	IC,(HN462732G)			
Q16	IC,(HN462732G)			
Q17	Not assigned			
Q18	Not assigned			
Q19	Not assigned			
Q20	Not assigned			
Q21	Di,(1S953)			
Q22	IC,(74LS04)			
Q23	IC,(74LS00)			
Q24	IC,(TC4042BP)			
Q25	IC,(TC4042BP)			
Q26	IC,(TC4514BP)			
Q27	IC,(74LS00)			
Q28	IC,(74LS00)			
Q29	IC,(74LS00)			
Q30	IC,(7404)			
Q31	IC,(74LS00)			
Q32	IC,(74LS138)			
Q33	IC,(TC4042BP)			
Q34	IC,(TC4027BP)			
Q35	IC,(7407)			
Q36	Not assigned			
Q37	IC,(TC4042BP)			
Q38	IC,(TC4052BP)			
Q39	IC,(HM6116ALP-20)			
R 1	CF,(ARD25T681J)	680Ω,±5%,1/4W		
R 2	MF,(RN14K2E4641D)	4.64kΩ,±0.5%,1/4W		
R 3	MF,(RN14K2E4641D)	4.64kΩ,±0.5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF CONTROL CIRCUIT

CKT REF	DESCRIPTION	RATING		NOTE
R 4	MF,(RN14K2E1212D)	12.1kΩ,±0.5%,1/4W		
R 5	MF,(RN14K2E1003D)	100kΩ,±0.5%,1/4W		
R 6	CF,(ARD25T683J)	68kΩ,±5%,1/4W		
R 7	CF,(ARD25T104J)	100kΩ,±5%,1/4W		
R 8	CF,(ARD25T681J)	680Ω,±5%,1/4W		
R 9	CF,(ARD25T331J)	330Ω,±5%,1/4W		
R10	Not assigned			
R11	Single in-line array, (IHR-8-223JA)	22kΩ x 8,1/8W		
R12	Single in-line array, (IHR-10-332JA)	3.3kΩ x 10,1/8W		
R13	CF,(ARD25T472J)	4.7kΩ,±5%,1/4W		
R14	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R15	CF,(ARD25T471J)	470Ω,±5%,1/4W		
R16	CF,(ARD25T471J)	470Ω,±5%,1/4W		
R17	CF,(ARD25T221J)	220Ω,±5%,1/4W		
R18	CF,(ARD25T221J)	220Ω,±5%,1/4W		
R19	Single in-line array, (IHR-10-472JA)	4.7kΩ x 10,1/8W		
R20	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R21	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R22	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R23	Var,MF,(RJ-6P 10kΩ)	10kΩ,1/2W		
R24	MF,(RN14K2E4872D)	48.7kΩ,±0.5%,1/4W		
R25	Var,MF,(RJ-6P 10kΩ)	10kΩ,1/2W		
R26	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R27	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R28	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R29	CF,(ARD25T103J)	10kΩ,±5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF DISPLAY CIRCUIT

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Cer,(CK924F1H104Z)	0.1μF,±10%,50V		
C 2	Cer,(CK924F1H104Z)	0.1μF,±10%,50V		
C 3	Cer,(CK924F1H104Z)	0.1μF,±10%,50V		
J 1	Connector, (HIF3-34P-2.54DSA)			
M 1	Meter,(44M65700)			
Q 1	IC,(μPA56C)			
Q 2	IC,(74145)			
Q 3	IC,(74145)			
Q 4	Display,(5082-7736)			
Q 5	Display,(5082-7740)			
Q 6	Display,(5082-7740)			
Q 7	Display,(5082-7740)			
Q 8	Display,(5082-7740)			
Q 9	Display,(5082-7736)			
Q 10	Display,(5082-7740)			
Q 11	Display,(5082-7740)			
Q 12	Display,(5082-7740)			
Q 13	Display,(5082-7740)			
Q 14	Not assigned			
Q 15 to Q 24	LED,(SR615D)			
Q 25	Tr,Si,NPN,(2SC2718)			
R 1	CF,(ARD25T151J)	150Ω,±5%,1/4W		
R 2 to R 12	CF,(ARD25T330J)	33Ω,±5%,1/4W		
S 1	Key,(KEC11901)			
S 2	Not assigned			
S 3	Key,(KEC11901)			
S 4	Key,(KEC11901)			
S 5	Not assigned			
S 6	Key,(KEC10001)			
S 7	Key,(KEC10001)			
S 8	Key,(KEC11901)			
S 9	Key,(KEC10001)			
S 10	Key,(KEC10001)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF DISPLAY CIRCUIT

CKT REF	DESCRIPTION	RATING		NOTE
S 11	Key,(KEC10001)			
S 12	Pushbutton,(8631CBE)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF 5V POWER SOURCE

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Elect,(CE04W1V4R7)	4.7μF,+100/-10%,35V		
C 2	Elect,(CE04W1V220)	22μF,+100/-10%,35V		
C 3	Plast,(ECQ-M05 104KZ)	0.1μF,±10%,50V		
C 4	Elect,(CE04W1A471)	470μF,+100/-10%,10V		
C 5	Elect,(CE04W1E471)	470μF,+100/-10%,25V		
C 6	Elect,(CE04W1E471)	470μF,+100/-10%,25V		
L 1	Coil,(SF-T12-150)	1mH,1.5A		
L 2	Coil,(SF-T8-50D)	130μH		
Q 1	Tr,Si,PNP,(2SA708)			
Q 2	Di,Si,(1S1834)			
Q 3	Di,Si,(1S1834)			
Q 4	IC,(μPC141C)			
Q 5	Di,breakdown,(RD5.1EB)	4.8 to 5.4V,400mW		
Q 6	Rectifier,(M4C-31-12)	3A		
R 1	CF,(ARD25T680J)	68Ω,±5%,1/4W		
R 2	CF,(ARD25T105J)	1MΩ,±5%,1/4W		
R 3	CF,(ARD25T152J)	1.5kΩ,±5%,1/4W		
R 4	CF,(ARD25T220J)	22Ω,±5%,1/4W		
R 5	CF,(ARD25T682J)	6.8kΩ,±5%,1/4W		
R 6	Var,MF,(RJ-6S 1kΩ)	Max.1kΩ		
R 7	CF,(ARD25T332J)	3.3kΩ,±5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

C.L. OF GP-IB (OPTION 02)

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Elect,(CE04W1V100)	10μF,+100/-10%,35V		
C 2	Elect,(CA92C1C1R000R56)	1μF,16V		
C 3	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 4	Plast,(ECQ-M1H104KZ)	0.1μF,±10%,50V		
C 5	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 6	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 7	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 8	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 9	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C10	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
J 1	Connector, (57L-20240-27CD5)	24P		
J 2	Connector, (HIF23A-20D-AA10S)	20P		
Q 1	IC,(74LS368A)			
Q 2	IC,(μPD7160)			
Q 3	IC,(74LS08)			
Q 4	IC,(74LS04)			
Q 5	IC,(74LS04)			
Q 6	IC,(74LS04)			
Q 7	IC,(84LS368A)			
Q 8	IC,(74LS14)			
Q 9	IC,(7438)			
Q10	IC,(74LS245)			
Q11	IC,(7438)			
Q12	IC,(7438)			
Q13	IC,(74LS368A)			
Q14	IC,(74LS04)			
R 1	Single-in,line type, array,(IHR-8-622JA)	6.2kΩ x 8,±5%,1/4W		
R 2	Single-in,line type, array,(IHR-8-302JA)	3kΩ x 8,±5%,1/4W		
R 3	Single-in,line type, array,(IHR-8-622JA)	6.2kΩ x 8,±5%,1/4W		
R 4	Single-in,line type, array,(IHR-8-302JA)	3kΩ x 8,±5%,1/4W		
R 5	Single-in,line type, array,(IHR-8-622JA)	6.2kΩ x 8,±5%,1/4W		
R 6	CF,(ARD25T682J)	6.8kΩ,±5%,1/4W		
S 1	Switch,(BP-8)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA95A

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Cer, (CC92CH1H470JY)	47pF,±5%,50V		
C 2	Cer, (CC92CH1H330JY)	33pF,±5%,50V		
C 3	Plast, (ECQ-M1H223KZ)	0.022μF,±10%,50V		
C 4	Plast, (ECQ-M1H104KZ)	0.1μF,±10%,50V		
C 5	Not assigned			
C 6	Tant, (CS02H1C220M)	22μF,±20%,16V		
C 7	Tant, (CS02H1C220M)	22μF,±20%,16V		
C 8	Cer, (CC92CH1H020CY)	2pF,±0.25pF,50V		
J 1	Connector (R15A-17R-16PB)			
K 1	Read relay, (REO113)			
K 2	Read relay, (REO113)			
Q 1	Di, photo, (S-1223-01)			
Q 2	IC, (TDB0156CM)			
R 1	MF, (GS1/2B 50MΩF)	50MΩ,±1%,1/2W		
R 2	MF, (GS1/4B 1MΩF)	1MΩ,±1%,1/4W		
R 3	MF, (RN05C2B1001D)	1KΩ,±0.5%,1/4W		
R 4	Not assigned			
R 5	Not assigned			
R 6	Not assigned			
R 7	MF, (RN14K2E5361D)	5.36KΩ,±0.5%,1/4W		
R 8	Var, MF, (POT1102P-1-502)	5KΩ,1/2W		
R 9	MF, (RN14K2E2001D)	2KΩ,±0.5%,1/4W		
R 10	MF, (RN14K2E4750D)	4.75KΩ,±0.5%,1/4W		
R 11	Var, MF, (POT1102P-1-102)	1KΩ,1/2W		
R 12	MF, (RN14K2E2000D)	200Ω,±0.5%,1/4W		
R 13	MF, (RN14K2E1001D)	1KΩ,±0.5%,1/4W		
R 14	Var, MF, (POT1102P-1-203)	20KΩ,1/2W		
R 15	Not assigned			
R 16	CF, (ARD25T221J)	220Ω,±5%,1/4W		
R 17	CF, (ARD25T221J)	220Ω,±5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA95A

CKT REF	DESCRIPTION	RATING		NOTE
Z 1	Tuning fork, (44H63972)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA96A

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Cer, (CC92CH1H470JY)	47pF,±5%,50V		
C 2	Cer, (CC92CH1H330JY)	33pF,±5%,50V		
C 3	Plast, (ECQ-M1H223KZ)	0.022μF,±10%,50V		
C 4	Plast, (ECQ-M1H104KZ)	0.1μF,±10%,50V		
C 5	Not assigned			
C 6	Tant, (CS02H1C220M)	22μF,±20%,16V		
C 7	Tant, (CS02H1C220M)	22μF,±20%,16V		
C 8	Cer, (CC92CH1H020CY)	2pF,±0.25pF,50V		
J 1	Connector (R15A-17R-16PB)			
K 1	Read relay, (RE0113)			
K 2	Read relay, (RE0113)			
Q 1	Di, photo, (FPD140-M3)			
Q 2	IC, (TDB0156CM)			
R 1	MF, (GS1/2B 50MΩF)	50MΩ,±1%,1/2W		
R 2	MF, (GS1/4B 1MΩF)	1MΩ,±1%,1/4W		
R 3	MF, (RN05C2B1001D)	1KΩ,±0.5%,1/4W		
R 4	CF, (ARD25T103J)	10KΩ,±5%,1/4W		
R 5	Not assigned			
R 6	Not assigned			
R 7	MF, (RN14K2E5361D)	5.36KΩ,±0.5%,1/4W		
R 8	Var, MF, (POT1102P-1-502)	5KΩ,1/2W		
R 9	MF, (RN14K2E2001D)	2KΩ,±0.5%,1/4W		
R 10	MF, (RN14K2E4750D)	4.75KΩ,±0.5%,1/4W		
R 11	Var, MF, (POT1102P-1-102)	1KΩ,1/2W		
R 12	MF, (RN14K2E2000D)	200Ω,±0.5%,1/4W		
R 13	MF, (RN14K2E1001D)	1KΩ,±0.5%,1/4W		
R 14	Var, MF, (POT1102P-1-203)	20KΩ,1/2W		
R 15	Not assigned			
R 16	CF, (ARD25T221J)	220Ω,±5%,1/4W		
R 17	CF, (ARD25T221J)	220Ω,±5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA96A

CKT REF	DESCRIPTION	RATING		NOTE
R18	Var,MF,(RJ-6S 20kΩ)	20kΩ,1/2W		
Z1	Tuning fork, (44H63972)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA97B

CKT REF	DESCRIPTION	RATING		NOTE
J 1	Connector, (HR10-7R-6P)			
Q 1	MP-1010			
R 1	Not assigned			
R 2	Var, MF, (POT1102S-1-203)	20KΩ,1/2W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA98A

CKT REF	DESCRIPTION	RATING		NOTE
J 1	Connector, (HR10-7R-6P)			
Q 1	Diode, photo B-1919-01			
R 1	MF, (RN14K2E4991D)	4.99kΩ, ±0.5%,1/4W		
R 2	Var, MF,(POT1102S-1-203)	20KΩ,1/2W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA911A/912A

CKT REF	DESCRIPTION	RATING		NOTE
J 1	Connector,(HR10-7R-6P)			
Q 1	Diode,photo,(MP-1010)			
R 1	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 2	Var,MF,(POT1102S-1-203)	20kΩ,1/2W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA913A

CKT REF	DESCRIPTION	RATING		NOTE
J 1	Connector,(HR10-7R-6P)			
Q 1	Diode,photo, (FPDI3T32WS/001)			
R 1	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 2	Var,MF,(POT1102S-1-203)	20kΩ,1/2W		

( ): Manufacturer's part number

* : Selected at factory

SECTION 10

DISASSEMBLY AND REASSEMBLY

The procedure for disassembly is shown. For reassembling, reverse this procedure.

(1) How to remove top cover (5) and bottom cover (6)

1. Remove two screws (15).
2. If GP-IB (option 02) is mounted, remove two screws (16).
3. Pull off the top cover, and also pull off the bottom cover.

(2) How to remove Z2 power source amplifier P.C. board (10).

1. Remove seven screws (20).
2. Disconnect two connectors.
3. Pull the P.C. board slantly rearward.

(3) How to remove Z5 GP-IB P.C. board (13).

1. Remove four screws (23).
2. Disconnect one connector.
3. Remove the P.C. board upward.

(4) How to remove Z3 control circuit P.C. board (11).

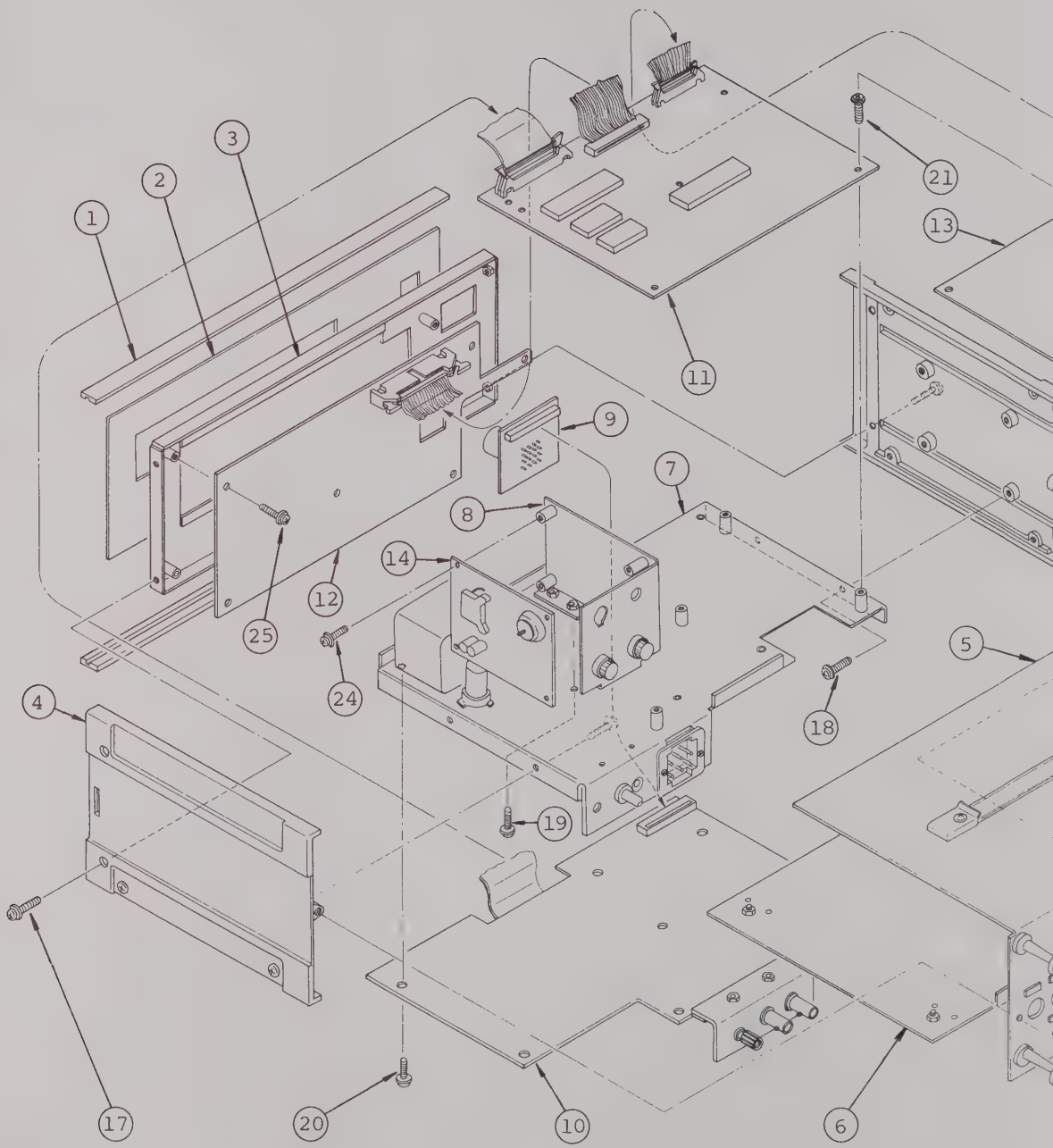
1. Remove GP-IB P.C. board in the order of (3).
2. If GP-IB is mounted, supports (22) are used in place of screws (21). Remove four supports (22).
   If it is not, remove four screws (21).
3. Disconnect two connectors.
4. Pull the P.C. board upward.

(5) How to remove Z4 display P.C. board (12).

1. Remove Z2 P.C. board in the order of (2).
2. Remove four screws (17) and four screws (18).
3. Pull off side board (4) to the side.
4. Remove two sashes (1) and front panel (2).
5. Disconnect connectors of Z4.
6. Remove six screws (25).
7. Remove the P.C. board.

(6) How to remove Z7 +5 V power source P.C. board (14).

1. Perform steps 1 ∿ 3 of (5).
2. Remove four screws (24).
3. Remove the P.C. board.
4. For replacing the P.C. board, remove wirings using a soldering iron.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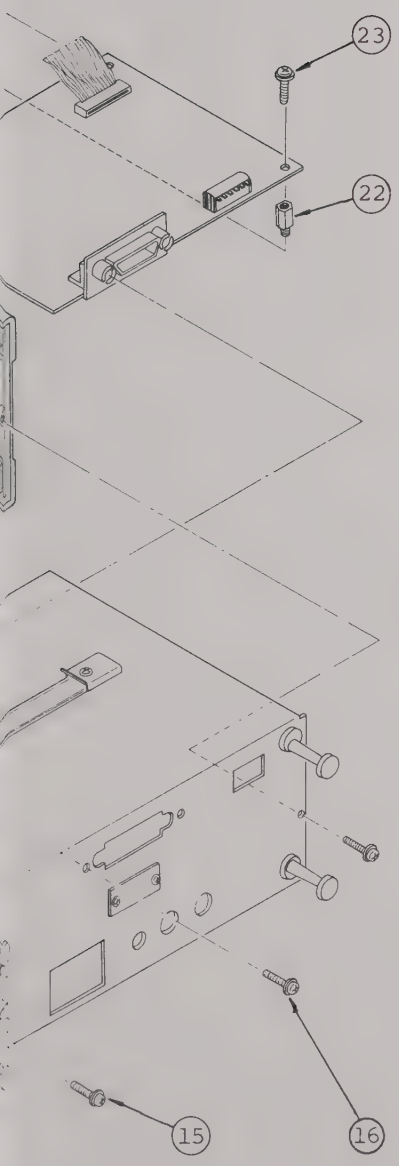

No.	Discription	Q'ty
①	Sash	2
②	Front Pannel	1
③	Sub Pannel	1
④	Side Board	2
⑤	Top Cover	1
⑥	Bottom Cover	1
⑦	Chassis	1
⑧	Sub-chassis	1
⑨	Z1 Connector Board P.C. Board	1
⑩	Z2 Amplifier Section P.C. Board	1
⑪	Z3 Control Circuit P.C. Board	1
⑫	Z4 Display Circuit P.C. Board	1
⑬	Z5 GP-IB P.C. Board	2
⑭	Z7 5V Power Source P.C. Board	2
⑮	Screw	2
⑯	Screw	4
⑰	Screw	4
⑱	Screw	4
⑲	Screw	4
⑳	Screw	7
㉑	Screw	7
㉒	Screw, Support	4
㉓	Screw	4
㉔	Screw	4
㉕	Screw	6

Fig. 10-1 Assemble

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